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AIR FORCE JOURNAL of LOGISTICS

"When we reach into our quiver of airpower arrows, we must first draw those forged from brains — not mass, money, or more materiel!"

Lt Gen Leo Marquez
HQ USAF DCS/Logistics
and Engineering

- *Air Base Survivability*
- *Technology and War*
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Purpose The *Air Force Journal of Logistics* provides an open forum for the presentation of issues, ideas, research, and information of concern to logisticians who plan, acquire, maintain, supply, transport, and provide supporting engineering and services for military aerospace forces. It is a non-directive, quarterly periodical published under AFR 5-1. Views expressed in the articles are those of the author and do not necessarily represent the established policy of the Department of Defense, the Department of the Air Force, the Air Force Logistics Management Center, or the organization where the author works.

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Air Base Survivability: An Essential Element of Theater Air Power

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Basic choices are involved in increasing ground survivability of air power assets. This author supports his advocacy for stressing mobility, dispersal, concealment, and deception.

The vital role of the air base in the application of air power has been neglected by the United States (US), despite the key role air power plays in our national strategy. This is particularly evident when examining the survivability of our overseas or theater air bases. Currently, two quite different methods are available for increasing air base survivability. One relies on hardening measures, active defenses, and rapid repair capabilities. This method is most suitable for conventional takeoff and landing aircraft that require sophisticated maintenance support, such as the F-15 Eagle. The other depends on dispersal, mobility, concealment, and deception measures for survival. The unique flight characteristics and improved system reliability of vertical/short takeoff and landing (V/STOL) aircraft, like the AV-8B Harrier II, make it well suited for this method. At this time, the first approach to basing survivability is generally preferred by most services, including the US Air Force. However, upon examination of both theater strategic requirements and the nature of war, only the second method offers a viable long-term solution. To understand why, we must first examine the threat facing theater air bases.

The Threat

Air bases can be attacked with a variety of munitions: nuclear, chemical, biological, and conventional. All these types possess a common characteristic—technological developments have significantly increased their lethality. In addition, simultaneous employment of combinations of these munitions may produce powerful and often unpredictable synergies.[1]

Technology also is making delivery methods more effective. Aircraft and missiles (both cruise and ballistic) are becoming more accurate, faster, and more effective over longer ranges. For targets as lucrative as the typical air base, an enemy may choose to employ special operations, airborne, and air-landed forces for air base attack. As with munitions, the simultaneous employment of different attack methods can create synergies which make successful air base defense less certain. Taking advantage of these capabilities, Soviet doctrine is increasing its emphasis on air base attack.[2] As a result, more and more Soviet forces are being designed and fielded with air base attack capabilities.

The operational feasibility and survivability of both basing methods depend on the ability to ensure aircraft have suitable operating surfaces and support (e.g., maintenance, fuel, munitions, and communications) despite enemy action. Until recently, the nature of the threat allowed many to assume that a hardened base was both operationally feasible and survivable. Simultaneously, many also assumed the problems associated with dispersion and mobility were too immense for this method to be operationally or economically feasible. However, recent developments in both threat and technology make it necessary to reexamine the validity of these assumptions.

Although the US used aspects of both methods in the past, air base survival was never a major consideration in choosing one or the other. In World War II, excepting the initial months, our air bases rarely were attacked. However, the advance of our ground forces dictated that basing for supporting fighters, light and medium bombers, and transports all needed mobility to keep pace.[3] This situation changed during the Korean War. Although US theater air bases continued to be relatively immune from attack, there was comparatively little movement by ground forces after the first year. The same situation also existed in Europe and later in Southeast Asia. As a result, airborne performance requirements came to dominate aircraft designs, often to the exclusion of basing considerations. These requirements demanded improved airspeed, range, and altitude capabilities, constrained only by technology and cost. Except for the Marine Corps, due to their expeditionary mission,

Mobility: Believing a tactical (theater) air force should operate from locations as close to the front lines as possible, Ninth Air Force moved to the continent shortly after D-day. The plan called for 35 advanced landing grounds by D+40, and within one week of the landing the first squadrons were using bases on the continent. During the remainder of the war in Europe, engineers often repaired damaged German fields, but approximately 30 percent of all bases were built from scratch. Above, the boots at the foot of the ladder testify to the respect this ground crew had for the P–38's role in the allied advance.

characteristics needed to operate from quickly established bases were not considered important. Thus, it seemed acceptable to produce aircraft like the F-15 that depended on long, hard, smooth takeoff and landing surfaces, and large, sophisticated, and expensive maintenance facilities.[4]

Alternative Responses

Now, because of the growing threat to our theater air bases, efforts are being made to make these bases survivable. To do this, the US is deploying active air defenses, dispersing and hardening aircraft shelters and support facilities (within the confines of the base), fielding rapid repair capabilities, and developing camouflage and deception measures. Given our tremendous investment in aircraft suitable only for operations from bases with long runways and large maintenance shops, and considering the current capability of the threat, this approach may be reasonable for the immediate future. However, as the threat continues to develop, we should assume that these measures may soon begin to have diminishing effect, making survival of air power dependent on such bases less certain.

We can rightfully assume this when we examine trends throughout the history of land and naval warfare. To cope with the increasing lethality of weapons, forces were obliged to depend more and more on mobility, dispersal, concealment, and deception for survival, despite the logistics and control problems associated with these measures. Even against conventional weapons, reliance on active defenses, armor, and damage control to protect a fixed, concentrated, and important facility was recognized—often reluctantly and at great cost—as inadequate for ensuring a reasonable probability of survival. And these trends are greatly magnified by the possibility of nuclear warfare.

Surprisingly, although US strategic nuclear forces are adapting to this reality, our theater air forces generally are not. Considering our great dependence on air power in theater conflict, failure to note the experiences of land and naval forces is particularly puzzling. If an enemy believes our theater air bases are vulnerable, especially to nuclear weapons, this could create an extremely destabilizing situation during a future crisis.

Fortunately, there is an alternative. The same method the Marines are using to ensure readily available air power can contribute to greater air base survivability. Significant increases in survivability, even against nuclear weapons, are possible by ensuring a portion of our theater aircraft do not require long runways and fixed logistics support. Without these requirements we would be able to expand exponentially our use of mobility, dispersal, concealment, and deception measures to increase air base survivability. The reason for this is found in the powerful synergies created when mobility is combined with dispersal, concealment, and deception measures. To understand why, we need to examine the impact *friction* has on both our ability to make a base survivable and an enemy's ability to attack it successfully.[5]

The Friction Factor

Such an examination shows that mobility makes aircraft more survivable on the ground, even when other measures such as dispersal, concealment, and deception are not used. Mobility increases an enemy's friction, decreasing confidence

Recently General (Ret) James P. Mullins, USAF, and Lieutenant General Leo Marquez, USAF, both called attention to the growing Air Force dependence on a very large, sophisticated, and costly logistics tail. General Marquez noted this is the result of pursuing performance and cost savings without regard to supportability. The result of this shortsighted policy, he concluded, is decreased flexibility.

that an attack will be effective, by making it more difficult to predict behavior and find aircraft locations. It also makes this information perishable. Therefore, an enemy planning to attack these aircraft needs more reliable and timely intelligence than if attacking aircraft whose ground location does not change. Even when such aircraft are found, an enemy cannot be sure when they will move again. This adds more uncertainty as an enemy must recognize there is an unknown, but limited, time to concentrate forces, and plan and execute an attack. This need to hurry decreases certainty the attack will be successful.

In addition, the effectiveness of dispersion, concealment, and deception measures is far greater when aircraft can change location rapidly and frequently. One reason is that, while both basing methods can employ dispersion, much more dispersion is possible if there is no requirement to remain near a few long, smooth operating surfaces and fixed support facilities that is the case with the typical hardened air base. Also, when aircraft are widely separated, it is possible even the detonation of a small yield nuclear weapon would affect only a few aircraft. This results in an enemy being less confident that a given attack—even one employing nuclear weapons—will produce a result worth the likely costs.

Deception and concealment are the two measures which, when employed with mobility and dispersal, are capable of creating the greatest uncertainty for an enemy.* Concealment makes it much more difficult for an enemy to find aircraft which can be moved frequently and quickly to another location. This is true because it is easier to conceal an aircraft than a runway. Also, deception is more effective for the same reason; decoy aircraft are easier to erect than decoy runways.

*Surprisingly, some United States military officers disagree; they oppose dispersing aircraft because they believe that modern intelligence capabilities make it impossible to hide. This perspective, which assumes technology can and will continue to eliminate uncertainty from war, reflects a dangerous ignorance of both history and technology. Instead of eliminating uncertainty, throughout history technology has often introduced even more friction and uncertainty into war. One reason is that the threat posed by technological advances provides a powerful incentive for man to develop countermeasures. Another problem resulting from technological advances has been the generation of unanticipated internal frictions. Current doubts regarding our ability to verify strategic nuclear agreements and the confusion involved in the Grenada action should demonstrate this reality.[6]

If, despite all these uncertainties, an enemy still decides to attack, the risk imposed by area defenses would remain the same, regardless of the basing method used. Considering the problems and uncertainties involved in attacking a theater air force which changes the location of its aircraft often and quickly, while simultaneously using dispersal, concealment, and deception, a prudent enemy could decide that an antiair strategy to attack aircraft on the ground is not feasible.[7]

Logistical Penalties?

At this point, some will note that mobility also imposes penalties on friendly operations. It creates friction by making support expensive and control difficult, while reducing an aircraft's airborne performance. Most assume this is true, but is it? The communications and logistic costs associated with mobility seem to be relatively obvious. Also, the unique characteristics of V/STOL aircraft, such as the AV-8B Harrier II, simultaneously make it smaller and slower than many short/conventional takeoff and landing aircraft that operate best from bases with long runways and sophisticated maintenance support.

However, a serious problem arises when those aware of these perceived limitations fail to compare them to the costs and frictions associated with operations from hardened air bases in war. When such a comparison is made, it turns out that the penalties for mobility and dispersion are not as severe as many believe, and may, in fact, be much *less* than those for air operations from hardened air bases.

One major reason is that frictions and costs associated with using mobility and dispersion are relatively similar in peace and war. In fact, this is really a major advantage since, with careful preparations and frequent exercises, the negative impact of friction can be reduced. In contrast, only actual war will create most of the frictions a hardened air base must overcome to survive and operate. Thus, in peace, these frictions may be unanticipated and preparations for war will prove inadequate. Even realistic exercises that include actual destruction of base facilities cannot duplicate the effects violence will have on personnel making rapid repairs or performing other vital activities. In addition, the tremendous costs of realistic exercises mean most personnel will never participate in one and will remain unaware of even those frictions present in such exercises.

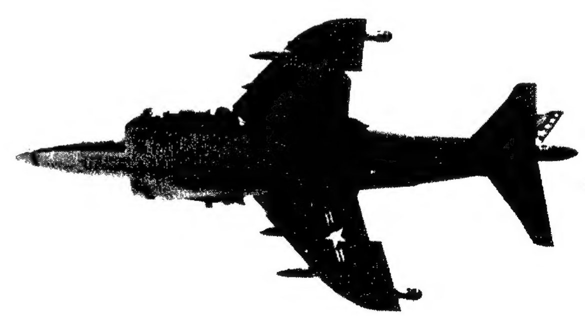
We can see some other differences imposed by friction when considering the impact of an air base attack using chemical and conventional area weapons, including air scattered mines. If the capability exists to change locations, the only chemical protection and mine clearing capabilities required are those needed to survive long enough to move to an uncontaminated location. In contrast, if changing locations is not possible, a capability to detect and clear mines, make rapid repairs, generate sorties, and defend against follow-up attack while remaining in a chemically contaminated environment is necessary. Comparing the two methods, commanders face much less uncertainty that they will be able to continue to operate if their forces possess mobility.

Operational Impacts

Before concluding that the use of mobility and dispersal is the superior method, there are two other elements not directly involving survivability which also need to be considered. As seen in World War II in the Pacific and in Normandy, being able to change operating locations allowed air power to keep pace with and provide responsive support for the movement of land forces. Therefore, aside from the great importance of responsiveness associated with proximity, this mobility also enables air power to be introduced quickly into areas of the world where few hardened bases exist. Even when such bases are available, they either may be far from where a battle is most likely to be fought or could be overrun by an enemy offensive. In fact, except for the Marine Harrier, the US approach to theater land-based air power seems to be founded on the assumption that movement and rapid intervention are no longer important factors in war. These assumptions become increasingly questionable given Soviet emphasis on rapid, deep penetrations by mobile ground forces. Thus, possessing basing mobility makes air power much more adaptable to the uncertainties of war.

The other element is the cost in airborne performance associated with mobility. A few take an extreme position that no compromise in airborne performance should be allowed. Obviously, compromises in performance are not only acceptable, but essential. Therefore, given that much greater survivability and flexibility are possible if aircraft can change locations, it seems reasonable to conclude these gains make some tradeoffs in airborne performance reasonable. However, upon closer examination, it may be that the perceived tradeoffs in airborne performance resulting from mobility do not actually exist, or at least prove to have little real impact on success in air combat.

Benjamin S. Lambeth, a senior staff member of Rand Corporation, points out that the Air Force's current approach to fighter development makes several errors by "confusing enemy force size with strength; mistaking technological sophistication for mission effectiveness; ignoring the importance of the human factor in warfare; and deriving force requirements from excessively restrictive definitions of operational need."[8] He believes it is vital that we keep in mind why an aircraft is being developed and what it is expected to do. As an example, he notes that while excess power was important, the 2.5 Mach capability of the F-15 was not needed for its intended operating context.[9] If our approach to fighter development eliminates the errors he mentions and keeps in mind the real purpose of the aircraft, we must face squarely the impact of friction on theater air operations.



The Marines have found the AV-8B to be a very reliable aircraft possessing an inertial system that gives low-level attacks a realistic chance of finding their targets. Weapons deliveries have achieved a circular error probability of less than 25 feet. Carrying 16 500-pound MK 82 bombs and 7,500 pounds of fuel, the AV-8B's combat radius is 150 NM. With six MK 82 bombs and 11,500 pounds of fuel, the radius increases to 450 NM. In 1989 the Marines plan to receive AV-8B's equipped for night, under-the-weather operations.

Taking this approach we may find that even the airborne performance of an early generation V/STOL aircraft like the Harrier does not necessarily impose a significant liability on combat operations. For example, one criticism of the Harrier is its subsonic airspeed. High airspeed can contribute directly to responsiveness, which is important for missions like close air support. However, for reasons of cost and survivability, aircraft performing this mission usually carry munitions externally. This produces drag, making very high airspeeds difficult to achieve. Increases in responsiveness can also be realized from airborne alert, but this requires either readily available air refueling or aircraft with great endurance. Besides the costs and complexities of each, airborne alert reduces the overall number of sorties a given force can fly. The remaining choice is to locate aircraft closer to the threat, as the Marines do with their Harriers. When all these factors are considered, the airspeed of mobile based Harriers is more than adequate for most air-to-ground missions.[10]

Another related criticism of the Harrier is its perceived lack of air-to-air capability. Yet during the AV–8B operational evaluation, when engagements required visual identification, the Marines found the AV-8B superior to all opponents (including the F/A-18, F-14, F-4S, and A-4M), achieving a 2:1 success rate. Although the AV-8B experienced an unfavorable loss ratio (4:1) to radar equipped aircraft when engagements did not require a visual identification, this may not be a significant handicap for an aircraft designed for air-to-ground missions.[11] In addition, developments in technology and tactics could make future dependence on radar far beyond visual engagements a liability in some situations.[12] Further, as a hedge, V/STOL aircraft could be made radar capable. The British are doing this by modifying their Sea Harrier FRS 2. Equipped with the Blue Vixen radar, the Sea Harrier will be able to carry four Hughes AIM-120 advanced medium-range air-to-air missiles (AMRAAM), as well as the AIM-9 Sidewinder.[13]

In Balance

In conclusion, to ensure service doctrine is not dogma, we must evaluate the impact of friction on the performance of both a combat aircraft and its basing concept. This evaluation should consider various basing concepts to see how each contributes to the overall survivability and flexibility of air power. If we were to assess the impact of friction on both our own actions and those of the enemy, it is very likely that we would find that aircraft not tied to long runways and elaborate maintenance support are much more survivable. Further, by studying the influence of friction, we would be able to see that the handicaps of such a basing concept are, in fact, far less significant than many assume.

Notes

[1]For instance, attempting to detect and clear mines scattered across a base by aircraft or missiles, while wearing chemical protective clothing and simultaneously performing active defense, generating sorties, and making repairs, presents an extremely complex challenge. The number of variables in effect may make it impossible to predict with confidence how well and how quickly these tasks will be performed.

[2]See the article by Phillip A. Peterson and Maj John R. Clark, "Soviet Air and Antiair Operations," *Air University Review*, March-April 1985, particularly pp. 37-39.

[3]Wesley Frank Craven and James Lea Cate, editors, *The Army Air Forces in World War II, Volume Three, Europe: Argument to V-E Day*, Office of the Air Force History, Washington, D.C., 1983, pp. 547-592.

[4]General James P. Mullins, USAF, "The Danger of Logistics Dependence," *Military Review*, August 1984, pp. 40-46; Lieutenant General Leo Marquez, USAF, "Spares, Prices, and Performance," *Air Force Journal of Logistics*, Fall 1984, pp. 9-11.

[5]Karl von Clausewitz (1780-1831) first introduced the concept of friction of war. He said friction is the force that makes the apparently easy so difficult. It is what "distinguishes real war from war on paper." The source of friction is the uncertainty inherent to war. Uncertainty results from variables that cannot be reliably predicted. One important variable is enemy behavior. Other important variables are the moral and physical effects produced by war's violence. Karl von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret, Princeton University Press, 1976, pp. 119-120.

[6]For an excellent treatment of the impact of technology on certainty and the nature of command, see Martin Van Crevald, *Command in War*, Harvard University Press, 1985.

[7]Although his focus is on the employment of strategic nuclear weapons, Benjamin S. Lambeth shows the keen awareness Soviet decision makers have on uncertainties associated with effectiveness in war. He concludes that Western planners who fail to consider the impact of uncertainty "are living in a world of sublime unreality." Benjamin S. Lambeth, "Uncertainties for the Soviet War Planner," *International Security*, Winter 1982-1983, p. 165.

[8]Benjamin S. Lambeth, "Pitfalls in Force Planning: Structuring America's Tactical Air Arm," *International Security*, Fall 1985, p. 92.

[9]Ibid., pp. 89, 90, 118.

[10]Brendan M. Greeley, Jr., "First Operational Marine Corps AV-8B Squadron Begins Service," *Aviation Week and Space Technology*, 16 September 1985, pp. 57, 59, 61.

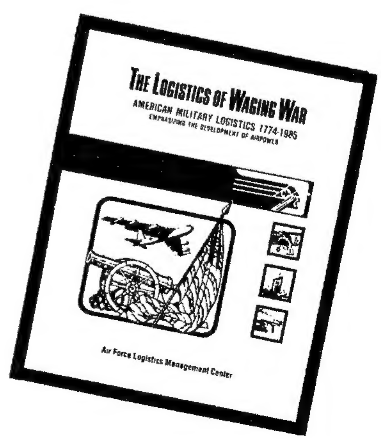
[11]Ibid., pp. 59, 61.

[12]Although this article focuses on ground based radar, it also has applications for radar controlled air-to-air engagements. James J. Pellien and Peter Williams, "The Tide Turns Against Radar," *NATO's Sixteen Nations*, November 1984, pp. 21-25.

[13]"British to Arm Updated Sea Harrier with AMRAAM Missiles," *Aviation Week and Space Technology*, 25 February 1985, p. 27. In fact the Sea Harrier has already proven its effectiveness against F-15s equipped with Sparrows. Commander Ward of the British Royal Navy observed that in his first engagements with the F-15 "not a single Sparrow kill was achieved (by the F-15), and seven of the eight first kills went to the Sea Harrier!" Commander N. D. Ward, "Some Reflections in the Operations of the Sea Harrier," paper given by a symposium on 10 October 1984 at the Royal Aeronautical Society.

Logistics History Available

To date, no single source has been available describing the development of American military logistics—particularly as it relates to airpower. To fill this gap, encourage deeper historical research, and promote understanding of logistics as an element of military strength, *AFJL* has published *The Logistics of Waging War*, a 200-page volume drawing on a wide range of documented sources. Copies may be obtained by contacting *AFJL* (AUTOVON 446-4087/Commercial 205-279-4087).



The Berlin Airlift: Foreign Policy Through Logistics

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The Berlin Airlift of 1948 is an outstanding example of the use of logistics as an instrument of foreign policy. As such, it deserves a larger place in military history than that which it is accorded.

After World War II, the United States (US) was the most powerful nation on earth, but had rapidly denuded herself of military strength following the end of the war. Although pursuing a policy of anti-Communism, the administration of President Harry S. Truman found itself with few military instruments of power. Consequently, as the Soviet Union challenged the US for supremacy in eastern Europe, there was little to be done to answer the challenge. Although according to Truman, "We had to lead from strength . . . any show of weakness was fatal," there was little military strength to use. (4:214) The nation's greatest strength was its economic power.

Against this backdrop, Truman faced the most serious crisis yet in the postwar period. The Soviets deliberately provoked a confrontation over Berlin, which had been divided among the four occupying powers (United States, Britain, France, and the Soviet Union). As Germany had been divided into east and west, so had Berlin. The Russians had sealed their zone of Germany from the other three. The United States, Britain, and France were cooperating in restoring normal economic conditions. In late summer of 1947, President Truman expanded the Marshall Plan for economic recovery of Europe to include West Germany. (4:120-21) Thus, the US substituted economic power for military power as an instrument of foreign policy.

The Soviets controlled access to Berlin through one railroad, the Autobahn, the canal network, and three 20-mile-wide air corridors. The occupying powers had agreed to the air corridors in writing, but there were no guarantees of access by land. (1:70) Truman later wrote:

> It would have made very little difference . . . whether or not there was an agreement in writing. What was at stake . . . was not a contest over legal rights, . . . but a struggle over Germany, and . . . over Europe. (4:123)

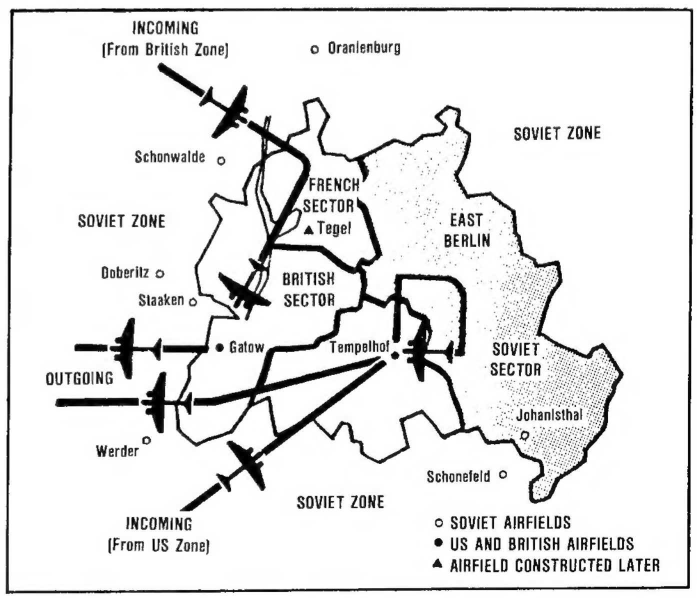
In spite of Truman's statement, he considered later American responses to the crisis within a legal framework, not a framework of power politics, which is what the Soviets understood and respected.

As the Soviets escalated the level of confrontation, the US searched for a response. The escalation began immediately after the war as the Soviets sought to consolidate their sphere of influence and spread Communism throughout Europe, taking advantage of the postwar chaos. Within Germany and Berlin, Soviet efforts were focused on the economy. The Russians had obtained plates of the occupation currency and flooded the western zone with worthless paper money, leading to massive inflation. In response, the western Allies announced a new currency, the Deutschemark This threatened Soviet plans to such an extent that, eventually, they would offer to lift the blockade if the new currency was not released. (4:122) When, on 20 March, the three western military governors agreed to make Deutschemarks the only legal tender in Berlin, the Russians responded by walking out of the Allied Control Council meeting. General Lucius Clay, American Military Governor of Germany and Commander, United States Forces in Europe, warned Washington of seriously strained relations and the possibility of war. (2:388)

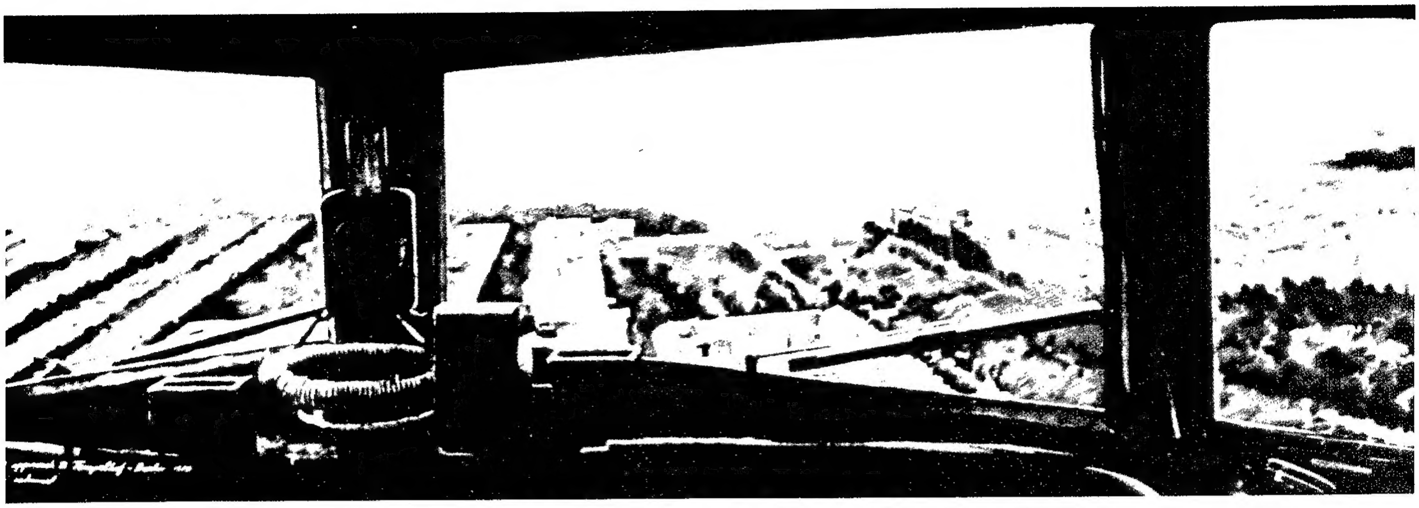
> **"Clay's immediate reaction was that the Allies must stay in Berlin."**

On 30 March, the Department of the Army asked Clay's opinion of whether to stop further dependent travel to Berlin and gradually withdraw dependents from Berlin and, eventually, all of Germany. Clay opposed the move, contending it would create hysteria among the Germans. Clay advised firmness. He was convinced the Soviets would not start a war and reminded Washington that weakness would not prevent one. (2:358-59) World War II had proven that.

The Soviets instituted systematic harassment of western traffic into Berlin and continued this policy through April, May, and June. On 20 June 1948, the Russians walked out of the Kommandatura (the four-power governing body of Berlin). Finally, on 23 June, the Russians declared that, beginning at 0600 the next day, they would stop all rail and Autobahn traffic due to "technical difficulties." They also stopped water



Airspace above Berlin. Note close proximity of Soviet airfields to Western air corridors. Incoming flights used the northern and southern corridors, outgoing flights the center corridor.



Approach to Tempelhof by Woodi Ishmael. In this painting from a C-54 cockpit, the author tried to capture windage and the feeling of the aircraft on the approach. Too rarely, however, was as clear a view as this available. Initially, all flights landed at Tempelhof or Gatow; later, Tegel was added.

traffic and coal shipments, and no longer supplied electric power produced in the Soviet sector to West Berlin. The blockade had begun. (1:71)

General Clay's immediate reaction was that the Allies must stay in Berlin. His staff, however, was less certain. Three of his advisors also opposed pulling out, while the remainder felt the Allies' position was untenable. After all, initial support from the Army and the State Department was weak; it was virtually impossible to defend Berlin militarily; and Clay's advisors were convinced the Russians were willing to go to war. Clay, though, was convinced the Soviets were bluffing, and his first impulse was to force an armed convoy through the blockade of the Autobahn. The British opposed this plan and threatened to withdraw their support. They proposed, instead, an airlift to supply the city. Based upon previous experience, Clay held little hope for success in supplying the occupation troops and the inhabitants of Berlin solely by air. British attempts at air resupply in World War I had failed. The Russians had failed at Leningrad and the Germans at Stalingrad. The only successful sustained airlift had been over the "Hump" in the China-Burma-India (CBI) theater in World War II. There were significant differences between the CBI and Berlin, primarily the 2.5 million inhabitants, who were almost solely dependent upon outside support for the basic necessities of life. (3:54-56)

With no alternatives, Clay began the airlift, initially for an interim period until other approaches could be developed. He made the decision with no planning and little evaluation of capability. No one knew whether an airlift was logistically feasible. President Truman and his Washington advisors contributed little to the decision. Clay, a military governor, was making foreign policy decisions thousands of miles from Washington. This delegation of authority was not conscious; rather, it resulted from a lack of action by anyone else.

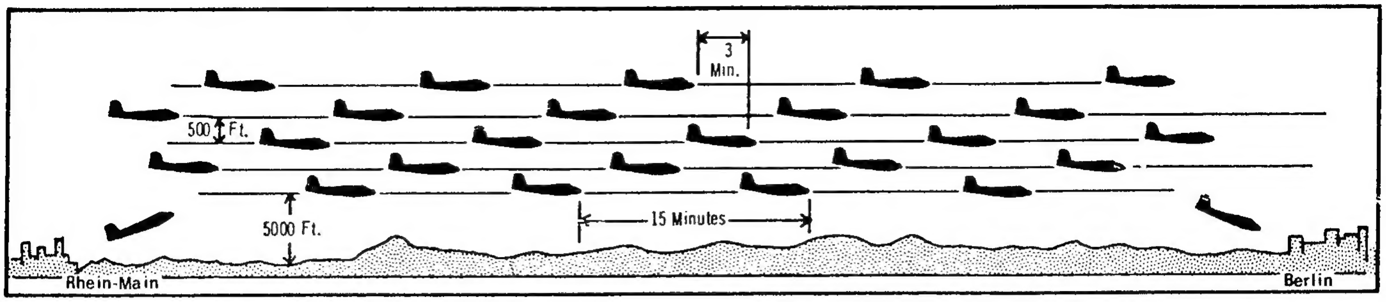
Clay did not believe a long-term lift was possible. There were few resources available. The US had only two troop carrier groups of C-47s in Europe, with a total of 102 aircraft. The British could contribute as many as 150 aircraft, but the French were already embroiled in Indo-China and would be able to contribute nothing. American crews flew the first missions 26 June and delivered a total of 80 tons of milk, flour, and medicine to the city. On 27 June, Clay decided to plan for a 21- to 45-day airlift. At that time, there was a daily requirement of 13,500 tons, but a lift capability of only 700 tons. (3:63-65)

General Clay made his decision on the length of the airlift without help from Washington. Secretary of Defense James Forrestal, Secretary of the Army Kenneth Royall, and Under Secretary of State Robert Lovett were divided in their counsel to Truman, but they were generally of the opinion that abandoning Berlin was the most logical course. Truman, however, refused to pull out and ordered a full-scale airlift, fully organized. As a show of strength, he also moved two squadrons of B-29s from Goose Bay, Labrador, to Germany, and two more from the United States to England. (3:66-67)

During the last week of June, the governments of the United States, France, and Great Britain issued statements of support for the people of Berlin. These statements escalated the issue beyond feeding the people into the realm of international power politics. The three governments opposing the blockade had several options. They could lodge formal diplomatic protests, bring the matter before the United Nations, implement economic sanctions (such as closing the Panama and Suez Canals to Soviet shipping), or break diplomatic relations. (3:74)

The western Allies and the Soviet Union conducted early negotiations through the four military governors. Washington wanted to go to the UN, while the British and French wanted further negotiations through the military governors or normal diplomatic channels. (2:367) Negotiations in Moscow proved ineffective, and all other diplomatic talks were futile. Stalin would appear to be conciliatory, but Vyacheslav Molotov, Soviet Foreign Minister, would revert to the "hard line" when it came time to compose the drafts of agreements. Efforts within the UN were also futile. (4:126-29)

On the American homefront, Clay was battling with the Air Force for more planes. He had requested a fleet of 160 C-54s, cargo planes of much greater capacity than the pre-World War II C-47s. The Air Force refused on the grounds that it would totally disrupt the Military Air Transport Service (MATS) and concentrate all strategic airlift capability in one location, where any adversary could easily destroy it. On 17 July, Truman called Clay to Washington to discuss the situation. The Joint Chiefs of Staff (JCS) were opposed to expanding the airlift because of the danger of being unable to respond to Soviet actions elsewhere. They estimated it would take



Cross-sectional view of flights into Berlin on 6 September 1948. Flights were separated at five levels with spacing allowing for landing one plane every three minutes. Later, two levels were used with landings at the same rate.

eighteen months to remobilize if war erupted. The Cabinet and National Security Council were also unsympathetic. President Truman, however, was more receptive to Clay's proposals. He overruled the JCS and Clay got his planes. (3:89-93)

With expansion of the airlift came the necessity for better organization. Major General William H. Tunner, who had commanded the Hump airlift, was assigned as commander of the Berlin airlift on 28 July 1948. Tunner changed a haphazard, "seat of the pants" operation into a highly regimented one. (1:73) By the end of the summer, capacity had increased to 5,000 tons per day. Tonnages continued to increase throughout the winter, and the airlift kept the city supplied with the basic necessities of life. Berlin officials and American military administrators determined requirements and priorities in Berlin. The Bizonal Administration in Frankfurt then requisitioned the supplies. The supplies moved by ship, rail, and truck to five airports in the western zone of Germany. American and British planes then airlifted them to the three Berlin airports, where the cargo was transferred to the German authorities. (2:382)

In late January of 1949 came the first hints that the Soviets were softening. They released a statement which did not link the currency problem to the blockade. (4:130) On 15 March 1949, the Soviets resumed negotiations. On 5 May, they announced they would lift the blockade on 12 May. The airlift had been successful.

"The use of logistics as an instrument of foreign policy is a viable alternative to other actions."

Although the Berlin Airlift was "accidental" foreign policy, in the sense that President Truman and his advisors did not consciously set out to use it as an instrument, it was successful foreign policy. There were historical precedents for such actions. The most successful example of the pursuit of foreign policy through logistics was the use of Lend Lease by President Roosevelt before the United States entered World War II. The greatest difference between Berlin and Lend Lease was the manner in which the actions were initiated. Clay implemented the airlift, and Truman allowed it to continue without much thought until he ordered the Air Force to provide more transports.

The use of logistics as an instrument of foreign policy is a viable alternative to other actions. There must, however, be an accurate assessment of capabilities in order that this option can be used effectively. In the case of the Berlin Airlift, neither Truman, Clay, nor the Air Force had any idea whether or not an airlift would work. This lack of knowledge had little impact in this particular case since Clay decided upon the airlift for lack of any better suggestions, rather than as the best possible choice from a list of alternatives.

The policymakers who decide upon such an operation must discuss the mechanics in great detail, and there is nothing glamorous or exciting about those details. As General Tunner pointed out:

> The last place you should find . . . [hustle and bustle and excitement] is in a successful airlift. The actual operation . . . is about as glamorous as drops of water on stone. There's no frenzy, no flap, just the inexorable process of getting the job done. (5:162)

One could say the same thing about any successful logistics operation.

As superpower military capabilities have been brought to bear on foreign policy, military options have been reduced. Logistics actions have become one of the most viable military alternatives. Since 1948, there have been several examples of foreign policy goals achieved through logistics, including the resupply of the Israelis by air during the Yom Kippur War of 1973. Although the United States did not want to become involved as a combatant, it clearly had a stake in the outcome of the war. Logistics provided the means to achieve that foreign policy objective, just as it did in 1948.

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"Gentlemen, the officer who doesn't know his communications and supply, as well as his tactics, is totally useless."

Gen George S. Patton, quoted at staff meeting during drive for Berlin

Reliability and Maintainability for Commodities?

Thomas W. Sherman, Jr.
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Although reliability and maintainability (R&M) are being pursued aggressively for designated systems, commodities have so far escaped much attention. This author breathes some life into the subject and offers a solution.*

The Need

Reliability and maintainability are big business in the Pentagon. Big bucks are being spent to achieve the goals of the Air Force's action plan *R&M 2000*. The other Services are at it, too.

Offices have been created, policy letters and directives are on the street, and even career development programs have been designed—all to improve R&M. But R&M of what? Weapon systems. Designated systems. Big ticket items. But what about commodities?

Deep in the innards of the air logistics centers and their equivalents in the other Services, procurement people toil in the mundane world of front-end loaders, welders, trucks, mess kits, air compressors, and generators—commodities. The resulting contracts add up to something like a quarter of the procurement budget—around $25 billion per year.

Thousands of contracts, many under $1 million (but even at that, it's a cut-throat world), are in work at any given time. But if you ask the procurement types, "What's the incentive to spend *your procurement dollars* in such a way that it will save *somebody else's O&M dollars?*" you'll get an answer similar to that of one value engineer: "You broke the code. There's no incentive."

R&M 2000 calls for assessment of R&M during design reviews. Design reviews? When was the last time anybody heard of a design review for a welding machine? Item managers who work welders probably work 10 other commodities as well, all by themselves. No staff, no nothing. Just an old beat-up metal desk someplace. Design review?

So what do they do? Since their world—the world of commodities—is essentially the world of competitive, off-the-shelf commercial products, they award contracts on the basis of price. Absent any better yardstick, they have to. Industry knows this, of course, and since its world is usually the commercial marketplace, which is fiercely competitive (and mostly by price), the two worlds fit nicely together.

But the commodity companies cannot afford to make the investment needed to attain R&M goals. In this price competitive arena, the first one to make a move would be priced out of competition, and there's the rub.

The problem is how to get commodity industries moving toward R&M goals at minimum (or no) cost to the government.

The Solution

What is needed is an approach which will compare—and help choose—products heading toward R&M. What is needed is a discriminator that is usable by the overworked contracting specialist in the world of commodities. It has to be credible; quick (it can't interrupt the provisioning cycle); cheap (it can't cost more than it saves); simple (it shouldn't require a mainframe—many vendors may not even have microcomputers); and, hopefully, commercially useful (to make it attractive to vendors).

Ideally, the approach would be developed in the field—where the rubber meets the road—because that's where the interface with industry is, and because the person who buys, for example, front loaders knows the industry a lot better than does the policymaker in the Pentagon.

R&M (and S for supportability and A for availability) can be attacked from several directions. But, remember, we're talking about commodities—commercial stuff; stuff that's at home on construction sites; stuff where the "ilities" are a little too abstract to attract attention.

People in the commercial world think in terms of dollars—the bottom line. And in that world (the real world?) the bucks that pay for *procurement* come out of the *same pocket* that pays for *operation and maintenance*.

> *"No hardhats here—you have to be a mathematician to play LCC-2, and have a mainframe."*

In the world of the bottom line, people who worry about these things talk about life cycle cost (LCC). To them, LCC makes sense, attracts attention, and matters. People who buy sedans for business fleets are very much concerned about the LCC of Fords vs. Plymouths vs. Chevys.

The Department of Defense (DOD) is also concerned about LCC but, once again, it is for those designated systems. The user documentation for USAF's LCC-2 Model runs well over an inch thick. No hardhats here—you have to be a mathematician to play, and you have to have a mainframe.

But you do not have to be a mathematician to understand the basics of what LCC is all about. The life cycle cost of something is simply what it costs to buy it plus what it costs to

*Designated system: singled out for special treatment. It normally has high visibility (including, in some cases, reports to Congress), specific management procedures, a program manager, and a line designation in the budget. (See AFM 11-1)

"Simple problems may be corrected in the Army provided the solution is complex; simple solutions to complex problems are not tolerated."

WEB Griffin, "The Majors," *The Brotherhood of War*, 1983.

run and maintain it minus what, if any, residual value is left at the end of its life. Simple, isn't it?

Some commodities may have a significant residual value, but most do not. A 10-year-old air compressor sold for salvage won't bring in much and, in any event, whatever scrap value it has won't affect its LCC significantly. So for the sake of simplicity, let's drop residual value. To those who work commodities containing precious metal (there must be some), please hang in there.

The gurus of LCC will say that the elegant calculations of LCC also include such things as training costs and transportation. True enough, they do. But remember, we're talking about commodities, things that compete in the commercial marketplace. You can bet that a commercial generator made by one company isn't much harder to learn to operate (i.e., "training costs") than that of another company. The first company won't be selling many machines if it is. Similarly, the first machine won't be much harder to transport around than the second for the same reason.

So let's call those two factors a "wash" and assign them equal value. Better still, let's drop them from our calculations.

At this point, alert readers may see that we've departed from the total of all LCC. What we're doing is narrowing our focus to the factors that are *different*—the deltas. We're looking at *comparative* LCC.

When we focus on the deltas, we're on the track of finding the discriminator for procurement.

In the world of construction machinery, for example, we can come up with a simple formula for comparative LCC:

Comparative Life Cycle Cost = Unit Cost + Operating Cost + Maintenance Cost

$$CLCC = BP + [(OC)(H)(Y)] + [(RMC)(Y)] + RPC$$

Where:

CLCC = Comparative Life Cycle Cost
BP = Bid Price Per Unit
OC = Operating Cost Per Hour
H = Number of Operating Hours Per Year
Y = Number of Years in LCC Period
RMC = Routine/Preventive Maintenance Cost Per Year
RPC = Repair/Unscheduled Maintenance Cost in LCC Period

Where does the contracting person get this information? Simple. Some of it can be assigned, and the rest comes from the competing vendors.

The contracting specialist can assign such things as the life cycle (in years); the number of operating hours per year; the rate (in dollars) per maintenance man-hour; the price of fuel, lube oil, coolant, etc. In this way, all vendors compete on a level playing field.

The next part is a little more difficult. The contracting type has to get data on what maintenance (periodic and unscheduled) actions are required, how long it takes to perform these actions, and how much the involved parts cost.

For periodic maintenance, the process is relatively simple. The bid request requires the vendors to submit with their bids the appropriate sections from their operator manuals. This provides the nature and frequency of required maintenance actions. The bidders are further required to use parts prices currently being charged to the government or, absent this, commercially. They must also state how long it takes to perform the various maintenance actions. These data are submitted on provided worksheets. And finally, bidders are told something like, "The apparent successful offeror will be required to demonstrate or otherwise verify the accuracy of the data." This keeps everybody honest. (It should be pointed out that this verification pertains to required maintenance. Performance testing, if required, would be handled in the normal fashion via First Article Test (FAT).)

For unscheduled maintenance, things get interesting. It turns out that in most commodities, neither the government nor industry keeps very good records. Commercial models keep changing; procurements are often spotty; and the resulting data base, if any, is statistically unreliable. But even more interesting is the fact that, in comparison with the overall LCC, unscheduled maintenance (RPC in the formula), even when tested with reasonable excursions, does not affect the outcome significantly, at least in the case of most construction equipment. This is probably because this stuff is out there in the competitive world where, if a company's machine is unreliable, it doesn't sell. In any event, for construction commodities, at least, we can forget unscheduled maintenance.

For illustrative purposes, Figures 1 through 4 provide a sample of worksheets for a machine being offered by a hypothetical MBM Manufacturing Company.

Figure 1 lists all routine maintenance actions required, their frequency, time to perform, parts prices, etc.

Figure 2 shows the calculations needed to determine operating cost per hour.

Figure 3 performs the calculations to determine the comparative LCC:

And Figure 4, used by the contracting people, compares the bidders.

"Selecting the right $5K machine would have saved the buyer more than $10K. Now that's a discriminator!"

What kind of discriminator does this approach give us? In one test case involving construction equipment, where equal prices were assigned machines of equal capabilities, the delta (for a 10-year life) was more than two times the purchase price. In other words, selecting the right $5K machine would have saved the buyer more than $10K. Now *that's* a discriminator.

PREVENTIVE/ROUTINE MAINTENANCE COSTS

MANUFACTURER: MBM MANUFACTURING CO.
MODEL: MBM-1

ITEM	MATERIAL: COST OF MATERIALS	MATERIAL: OPERATING HOURS BETWEEN OPERATIONS	MATERIAL: NUMBER OF OPERATIONS PER YEAR BASED ON 600 HOURS PER YEAR	MATERIAL: TOTAL COST OF MATERIAL PER YEAR	LABOR: MANHOURS REQUIRED TO PERFORM SERVICE OR REPLACE PART	LABOR: NUMBER OF REPLACEMENTS OR SERVICING REQUIRED PER YEAR	LABOR: TOTAL YEARLY MANHOURS REQUIRED TO SERVICE OR REPLACE PARTS	LABOR: MANHOUR RATE IN DOLLARS PER HOUR	LABOR: TOTAL MANHOUR COST PER YEAR	TOTAL COST OF SERVICING OR REPLACING PARTS PER YEAR IN DOLLARS — MATERIAL PLUS LABOR
CHECK TRANSMISSION FLUID LEVEL	—	100	6	—	0.05	6	0.3	25.00	7.50	7.50
CLEAN TRANSMISSION FLUID FILTER/STRAINER	—	1000	0.6	—	1	0.6	0.6	25.00	15.00	15.00
CHECK ENGINE FULL LOAD SPEED	—	1000	0.6	—	0.1	0.6	0.06	25.00	1.50	1.50
CHECK ENGINE IDLE SPEED	—	1000	0.6	—	0.1	0.6	0.06	25.00	1.50	1.50
CHECK ENGINE LUBRICATING OIL LEVEL	—	8	75	—	0.05	75	3.75	25.00	93.75	93.75
CHANGE ENGINE LUBRICATING OIL	5.00	250	2.4	12.00	0.5	2.4	1.2	25.00	30.00	42.00
REPLACE ENGINE LUBRICATING OIL FILTER	7.50	250	2.4	18.00	0.1	2.4	0.24	25.00	6.00	24.00
CHECK ENGINE COOLANT LEVEL	—	8	75	—	0.05	75	3.75	25.00	93.75	93.75
DRAIN, FLUSH AND REPLACE ENGINE COOLANT	20.00	SPRING & FALL	2	40.00	2	2	4	25.00	100.00	140.00
CLEAN RADIATOR EXTERNAL SURFACES	—	100	6	—	1.5	6	9	25.00	225.00	225.00
INSPECT COOLING SYSTEM AND AIR INLET HOSES	—	500	1.2	—	0.5	1.2	0.6	25.00	15.00	15.00
CHECK AIR FILTER ELEMENTS	—	8	75	—	0.05	75	3.75	25.00	93.75	93.75
REPLACE OR CLEAN AIR FILTER ELEMENTS	100.00	YEARLY	1	100.00	0.25	1	0.25	25.00	6.25	106.25
CHECK OR FILL BATTERY ELECTROLYTE LEVEL	—	100	6	—	0.25	6	1.5	25.00	37.50	37.50
CHECK OR REPLACE PCV VALVE	—	YEARLY	1	—	0.1	1	0.1	25.00	2.50	2.50
REPLACE OR CLEAN ENGINE FUEL FILTER	5.00	500	1.2	6.00	0.25	1.2	0.3	25.00	7.50	13.50
FILL ENGINE FUEL TANK	—	8	75	—	0.2	75	15	25.00	375.00	375.00
DRAIN CONDENSATE FROM ENGINE FUEL TANK	—	YEARLY	1	—	0.5	1	0.5	25.00	12.50	12.50
LUBRICATE ENGINE SPEED LINKAGE	—	400	1.5	—	0.1	1.5	0.15	25.00	3.75	3.75
INSPECT V-BELTS FOR CONDITION	—	250	2.4	—	0.1	2.4	0.24	25.00	6.00	6.00
CLEAN COOLING FINS (AIR COOLED ENGINES)	DOES NOT APPLY - WATER COOLED ENGINE									—
CHECK TURBOCHARGER (IF EQUIPPED)	—	YEARLY	1	—	0.5	1	0.5	25.00	12.50	12.50
CHECK PROTECTIVE DEVICES (IF EQUIPPED)	—	YEARLY	1	—	1	1	1	25.00	25.00	25.00
GREASE PACKAGE RUNNING GEAR	—	1000	0.6	—	2	0.6	1.2	25.00	30.00	30.00
CHECK TIRES FOR CORRECT INFLATION PRESSURE	—	BEFORE USE	75	—	0.05	75	3.75	25.00	93.75	93.75
LUBRICATE TACHOMETER DRIVE	—	250	2.4	—	0.05	2.4	0.12	25.00	3.00	3.00
LUBRICATE PILOT BEARINGS	—	125	4.8	—	0.1	4.8	0.48	25.00	12.00	12.00
CLEAN FUEL TRANSFER PUMP STRAINER	—	500	1.2	—	1	1.2	1.2	25.00	30.00	30.00
CHECK AND ADJUST ENGINE VALVE CLEARANCE	—	2500	0.24	—	8	0.24	1.92	25.00	48.00	48.00
REMOVE AND CLEAN ENGINE BREATHER	—	1000	0.6	—	1	0.6	0.6	25.00	15.00	15.00

DATE: SEPTEMBER 3, 1986

TOTAL PREVENTIVE/ROUTINE MAINTENANCE COST PER YEAR = $1579.00

Figure 1: Maintenance Data.

OPERATING COST PER HOUR

MANUFACTURER: MBM MANUFACTURING CO.
MODEL: MBM-1 DATE: SEPTEMBER 3, 1986

$$OC = (F \times C) + (EO \times K)$$

WHERE:
OC = OPERATING COST PER HOUR.
F = FUEL CONSUMPTION IN GALLONS PER HOUR WITH ENGINE OPERATING UNDER FULL LOAD CONDITION AT RATED SPEED.
C = COST OF FUEL IN DOLLARS PER GALLON.
EO = ENGINE LUBRICATING OIL CONSUMPTION IN GALLONS PER HOUR WITH ENGINE OPERATING UNDER FULL LOAD CONDITION AT RATED SPEED.
K = COST OF ENGINE LUBRICATING OIL IN DOLLARS PER GALLON.

F = 3.25 GALLONS PER HOUR
C = $1.00 PER GALLON
EO = 1/2 % OF FUEL CONSUMPTION = 0.01625 GALLONS PER HOUR
K = $4.00 PER GALLON

$$OC = (F \times C) + (EO \times K)$$
$$OC = (3.25 \times 1.00) + (0.01625 \times 4.00)$$
$$OC = 3.25 + 0.065$$

OC = $3.315 PER HOUR

Figure 2: Operating Costs.

COMPARATIVE LIFE CYCLE COST SUMMARY SHEET

BASED ON 600 OPERATING HOURS PER YEAR OVER A 10 YEAR LIFE CYCLE COSTING PERIOD

DATE: SEPTEMBER 3, 1986

MANUFACTURER	MODEL	ENGINE	UNIT BID PRICE	OPERATING COST DURING LIFE CYCLE COSTING PERIOD	PREVENTIVE MAINTENANCE COST DURING LCC PERIOD	COMPARATIVE LIFE CYCLE COST
MBM MANUFACTURING CO.	MBM-1	PTS DIESEL - 150	$10,000.00	$19,890.00	$15,790.00	$45,680.00
FBN INC.	CAD	ECON DIESEL 160	$9,800.00	$18,972.00	$19,665.00	$48,437.00
DC AND H INC.	MODEL HR	FG 152 DIESEL	$10,100.00	$19,584.00	$20,540.00	$50,224.00
H.E MANUFACTURING	HE-1	155 DIESEL	$10,200.00	$20,502.00	$17,665.00	$48,367.00

Figure 4: Bidder Comparison.

COMPARATIVE LIFE CYCLE COSTING

MANUFACTURER: MBM MANUFACTURING CO.
MODEL: MBM-1 DATE: SEPTEMBER 3, 1986

$$CLCC = BP + [(OC)(H)(Y)] + [(RMC)(Y)]$$

WHERE:
CLCC = COMPARATIVE LIFE CYCLE COST
BP = BID PRICE
OC = OPERATING COST PER HOUR
H = NUMBER OF OPERATING HOURS PER YEAR
Y = NUMBER OF YEARS IN LCC PERIOD
RMC = ROUTINE/PREVENTIVE MAINTENANCE COST PER YEAR

BP = $10,000.00
OC = $3.315
H = 600 HOURS
Y = 10 YEARS
RMC = $1579.00

$$CLCC = BP + [(OC)(H)(Y)] + [(RMC)(Y)]$$
$$CLCC = 10000 + [(3.315)(600)(10)] + [(1579)(10)]$$
$$CLCC = 10000 + 19890 + 15790$$

CLCC = $45,680.00

Figure 3: LCC Calculations.

An analysis quickly identified the major source of this wide variation in comparative LCC—it was required maintenance. The costs of maintenance man-hours required to do those routine oil changes, filter changes, etc., do add up. And identifying costs like that are important in the commercial world.

And what does it do for DOD? It captures two of the ilities—maintainability and availability.

Several LCC gurus have reviewed the approach of "focusing on the deltas" for commodities and, after expressing some initial disdain because of its inelegance, agree it makes sense. One LCC value engineer observed, "Going from the ilities of R&M to the dollars of LCC deltas is rather like going from qualitative to quantitative."

"The emphasis is on smart, not big."

The Advantages

The use of comparative LCC—focusing on the deltas—yields several advantages which make it ideal for the commodity environment:

- The approach is adaptable to several kinds of commodities, especially machinery.
- We get a blood brother of R&M.
- The approach is quick. Therefore,
  - it won't interrupt the provisioning cycle, and
  - the calculations can be performed prior to contract award, precluding liability hassles.
- The approach is cheap. A few hours of verification time is involved, or the government could perhaps use Independent Testing Lab reports.
- It precludes the need for extensive record-keeping. This
  - avoids statistical problems like determining adequate sample sizes and calculating standard deviations, and
  - allows new companies—those without an extensive track record —to compete. The emphasis is on smart, not big.
- It's credible—one doesn't have to be a mathematician to understand it. Credibility makes it difficult to argue against the use of comparative LCC. In the words of one legislative liaison officer, "It'd be like fighting motherhood."
- The calculations provide routine maintenance man-hours per operating hour (MMH/OH). While this may be too abstract for use in the commercial world, there are people in DOD who are very much interested in these figures. As one value engineer said, "In an ideal situation with a homogenous fleet, a lower MMH/OH would allow the government to purchase less units and still get the job done."
- The concept can be, and is, used commercially. It provides an advertising "hook" that R&M abstractions do not. Commercial customers want data in dollars, not hours.
- Most important to DOD, the use of comparative LCC will drive commodity industries in the direction of R&M, because they are in a competitive arena. If DOD adopts this approach, we'll begin to see:
  - "The battle of the manuals." Routine maintenance requirements will be studied and, in many cases, reduced. Right now, little attention is paid to manuals. For example, where engine manufacturers have reduced the required frequency of oil changes, the manufacturers of machinery that these same engines power have not similarly reduced the frequency of required engine oil changes in their operator manuals. Dumb? Sure. Reason? Inattention to detail. Result? Cost to the user. In the military, there are technicians changing the oil more often than they need to, and there are maintenance superintendents making sure they do. That adds up to lots of maintenance time.
  - Value engineering. Driven by competition, we'll begin to see access panels popping up so technicians can more easily change that oil. Or "1000 hour" this, or "lifetime" that. Maybe even built-in test equipment. Driven by competition, both in DOD and commercially, you can bet that those smart industry engineers will be heading toward R&M goals. And those who do it best, who provide the lowest comparative LCC (and therefore the best R&M), will be rewarded by the marketplace.

In short, if the government adopts the comparative LCC approach for commodities, it will drive industry to think and act smarter in the direction of R&M 2000 goals.

"When the Pentagon goes gunning for commodities, it may be tempted to use B-1 procedures on mess kits and welders—could be a bit cumbersome."

A Recommendation

There is a bow wave in front of that $25 billion tab for commodities mentioned earlier. When the folks in the Pentagon have satisfied themselves (and Congress and whoever else) that R&M for big ticket items is under control, they will go gunning for commodities. And for the people toiling in the thankless world of commodity procurement, a danger lurks here. The danger is that when the Pentagon goes gunning for commodities, it may be tempted to use B-1 procedures on mess kits and welders. Could be a bit cumbersome.

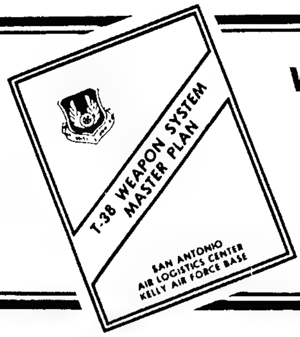
It would seem prudent for the field people—the troops in the trenches—to strike first. They know their industry. They know the players. They know what the traffic will bear. And they know which nerves to strum to best get their vendors heading in the direction of R&M. While comparative LCC may not be the answer for all situations (like one buyer said, "Whaddaya want, I should life cycle cost an open-end wrench?"), it seems a good place to start for many.

Where appropriate, contracting people, logisticians, and others at the working level can start with this approach. Adapt it as necessary to fit the industry involved, get industry participation (they'll play—they know bucks when they see them), and get it moving.

R&M is coming for commodities. Comparative life cycle costs can make it happen.

"We have learned and must not forget that, from now on, air transport is an essential of airpower, in fact, of all national power."

General H. H. "Hap" Arnold (1945)



Weapon System Master Plan (WSMP): Planning Today for Combat Effectiveness on Tomorrow's Battlefield

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"Aircraft on the ramp now will probably account for 70% of the Air Force's aircraft in the year 2000."

The United States Air Force (USAF) in the year 2000 will not be significantly different from today's Air Force unless we change the way we support the forces. Aircraft on the ramp now will probably account for 70% of the Air Force's aircraft in the year 2000. The present focus on just providing the resources to generate the sorties needed in war plans does not provide the necessary emphasis on total system effectiveness. Many efforts have vividly displayed shortfalls in spare parts, missiles, and munitions. These efforts did not, however, address how to conduct weapon system resource tradeoffs to maximize total operational effectiveness. We preached the *idea* of weapon system management, but had not developed the tools or provided the system program manager (SPM) the controls required to make it possible. The Air Force Logistics Command's (AFLC) WSMP process is an important step in transforming a command that *reacts* to problems into one that *anticipates* opportunities.

In trying to ensure that Air Force support dollars contribute to maximum battlefield effectiveness, past major operational commanders, engineering developers, and logisticians have focused their own planning efforts within the confines of unique and often isolated environments. Within AFLC long-range plans for weapon system management had always existed. However, these were generally partial plans, such as the modification management plan for the F-111 and the "Pacer Classic" service life extension program for the T-38. These and similar plans, particularly the excellent four-volume Minuteman planning series, served as the basis for the current initiative, which is now being sponsored by the Air Staff. This initiative is the development of a single master plan for *each* weapon system which will be that system's primary planning document after program management responsibility transfer (PMRT). Basic acquisition documents, such as Program Management Plans, will serve as the pedigrees of the WSMPs.

The WSMP Concept

A WSMP is an integrated document that defines the future support plans for a weapon system based on projected threats and operational requirements. It integrates support requirements and develops support funding profiles. The WSMP emphasizes coordinated projections for enhancing combat capability, survivability, and reliability and maintainability (R&M). The plan draws from USAF and major command projections of operational requirements and identifies the resources, modifications, and technology insertion/transition opportunities needed to support the system and its missions. Weapon system unique infrastructure requirements are also included to present a comprehensive overview of weapon system support requirements.

These documents provide planners and programmers with a responsive plan that considers changing threats and mission requirements, projects these requirements along with technological opportunities, and provides support planning information to ensure the availability and supportability of each weapon system for future wartime employment.

Specifically, the objectives of a WSMP are to:

- provide managers with sufficient data on which to base advocacy positions;
- allow support plans to be based on an assessment of future threats and operational mission requirements;
- provide managers with current employment and support requirements to allow effective resource allocation and modification development/integration consistent with changing weapon system long-range needs and employment concepts; and
- systematically resolve R&M problems.

The Master Planning Cycle

There are six questions in the master planning cycle that the AFLC system program manager (SPM) uses to provide the continuous flow of data, analyses, and information required to accomplish long-range weapon system planning (see Figure 1):

PART I: Mission Requirements

(1) *What do I have to do with my weapon system?*

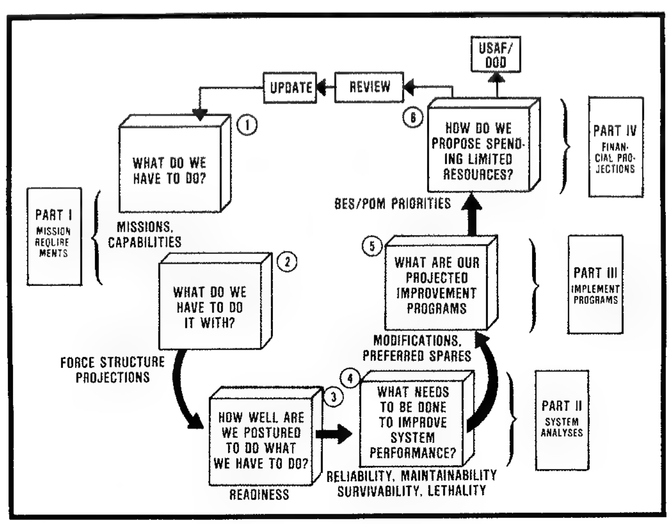

Figure 1: Master Planning Cycle.

For each weapon system there is at least one mission. War plans are carefully examined, and the variables of scenario, employment strategy and tactics, threats, and each weapon system's capabilities are projected. The Air Force mission is not static, so it should be noted that the WSMP approach is designed to adapt to all mission changes. The major using commands play a big part; they are the ones that know the threats and their future needs to meet the threat. Their inputs serve as the foundation for the rest of the plan.

(2) *How many weapon systems are required to successfully accomplish the mission?*

The planner's next step is to project the force structure expected. This too is subject to continual changes.

(3) *How well am I postured to do the mission?*

The planner must see if the force structure projection is showing an adequate force considering estimates and projections of mission capable rates. The SPM then compares the number of weapon systems required to successfully accomplish the mission to the number of weapon systems projected to be available. Force structure planning identifies any shortfalls.

PART II: System Analyses

(4) *What needs to be done to improve system performance?*

Projections of essential logistics support to achieve required mission capable rates are the SPM's next effort. Analyses are made to determine areas of necessary improvement. The SPM focuses on ways to improve the weapon system's capabilities and performance. For example, to make maintainability improvements, the SPM uses failure data, materiel deficiency reports (MDRs), readiness degradation statistics, maintenance man-hour analyses, analytical condition inspection results, and interviews with maintenance personnel to determine problem areas. Additionally, analyses of a weapon system's reliability, survivability, and lethality are necessary to ensure its capabilities are not compromised by new enemy threats or degraded by loss of inherent system performance.

PART III: Program Implementation

(5) *What are my projected improvement programs?*

Next is the key step—turning the analysis of needs into the specific sustaining engineering, modifications, replacement equipment, investment spares, and other logistics programs needed for supporting the system.

(6) *How do I propose spending limited resources?*

The SPMs—again, in conjunction with the using commands—now have the task of ranking programs to gain the highest combat capability from the limited resources allocated for their systems. Ranking and justifying alternatives cap off the process. Although this is the last step in the master planning process, it is the most important.

The cycle is continuous. The SPMs and MAJCOMs review and update the plans using changes in required capabilities, new Statements of Need, Air Force Systems Command "Vanguard" inputs, changes in funding profiles, etc. This process continues until the end of the weapon system's life cycle.

R&M Attack

WSMPs include *R&M 2000* plans for respective weapon systems. *R&M 2000* is USAF's program to equate R&M with cost, schedule, and performance. AFLC is zeroing in on the weapon system "bad actors" that result in high war readiness spares kit (WRSK) stockage levels. WRSK supports units which fight away from home. The kits are designed to support the first 30 days of conflict and are maintained in mobility bins, ready to be rolled out for deployment.

"The objective is to drive the MTBF beyond ten times the first 30 days' flying hours."

The actual technique is elegantly simple (see Figure 2). The senior AFLC leadership decided that, as a beginning goal, every aircraft subsystem having a mean time between failure (MTBF) of less than twice the flying hour requirement for its first 30 days of wartime flying should be upgraded. The objective is to drive the MTBF beyond ten times the first 30 days' flying hours. The intermediate goal is to upgrade everything with an MTBF of four times the first 30 days' flying hours or less and, in the long term, drive every five-digit work unit code beyond ten times the first 30 days' flying hours.

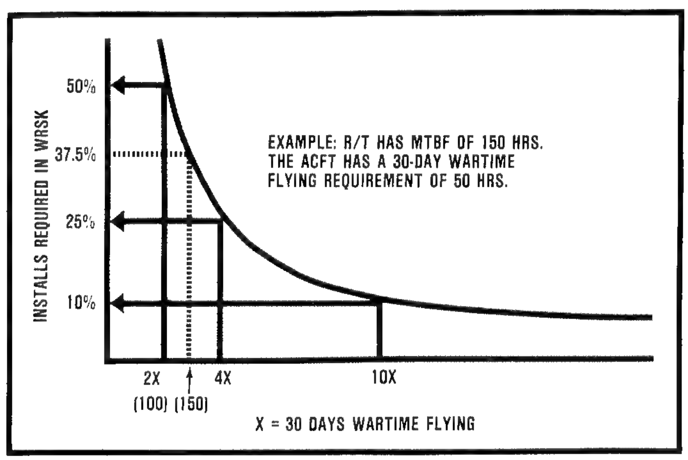

Figure 2: WRSK Requirement.

For example, a typical fighter squadron would be expected to fly about 65 hours per aircraft during the first 30 days of a high-intensity conflict. Doubling that yields a target MTBF of 130 hours. If a line replaceable unit (LRU) has an MTBF of 130 hours, the WRSK needs 50% of the installs. In the example of a 24-primary aircraft authorized (PAA) squadron, the WRSK would need 12 units. Assuming perfectly uniform failures, 12 units would be expected to fail and would need replacing.

If we can get each LRU to an MTBF of 2X or higher, then no more than 50% of the installs of any LRU would be required in a WRSK. At 4X, only 25% of installs would be required, and at 10X, theoretically *no* units are needed.

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Revised BPIE Criteria

The Department of Defense has proposed a revision to the Base Procured Investment Equipment (BPIE) expense/investment criteria in the FY88/89 President's Budget. The proposal increases the BPIE unit cost threshold from $5,000 to $25,000. The impact will be enhanced oversight capability for local commanders to fund prioritized requirements within allocated resources and will afford them an opportunity to be more responsive to unanticipated requirements. Also, the change will allow the majority of base operating support items to be funded with operation and maintenance (O&M) funds. This revised budget policy is a continuing effort from the FY86 President's Budget to arrive at an optimum threshold which promotes more flexibility and economic efficiency in sourcing BPIE requirements at the local level. It will relieve many execution problems caused by fluctuating equipment unit prices and uneconomical lease vs buy situations. (Ms Ethel Jones, AF/LEXP, AUTOVON 225-7031)

New WRM Rules

AFR 400-24, *War Reserve Materiel (WRM) Policy,* has been revised and is currently being distributed through your servicing publishing distribution office (PDO). This revision (dated 28 Nov 1986) expands the policy on peacetime use of WRM; modifies guidance for war readiness spares kits (WRSK), base-level self-sufficiency spares (BLSS), follow-on spares kits (FOSK), and other war reserve materiel (OWRM); adds and defines new bare base equipment (nicknamed Harvest Falcon); expands NATO prepositioned procurement package (PPP) policy; expands war consumables distribution objective (WCDO) requirements development; and changes and clarifies subsistence policy. (Lt Col Fred Smith, AF/LEXX, AUTOVON 227-2831)

Third Generation Avionics Coming

The Air Force is passing through the second generation of avionics architecture. First generation analog systems of the pre-1960 era were produced and installed as distinct independent entities. Malfunctioning components had to be completely disassembled to replace or repair the defective parts. The first generation digital systems of the mid-1960s employed the line replaceable unit/shop replaceable unit concepts and component packaging was driven by aircraft design. Second generation digital systems feature integration of individual subsystems using semiautomatic test equipment which created extensive financial, facility, and airlift demands. A third generation architecture is evolving, the key to which is utilization of *line replaceable modules*. In order to establish a logistics support concept for the modular avionics systems architecture, the Air Force has established a Tiger Team composed of using and supporting command representatives. The expected publication date of Air Force Regulation 800-45, *Modular Avionics Systems Architecture Integrated Logistics Support Requirements,* is Mar 87. (Lt Col Gary Crawford, AF/LEYY, AUTOVON 227-3805, or Commercial (202) 697-3805)

"Rivet Train" Seeks Ideas

The HQ USAF Deputy Chief of Staff for Logistics and Engineering has commissioned a total assessment of the aircraft maintenance training system. The objective of the review is to make aircraft maintenance training programs more effective, more efficient, and less burdensome to unit supervisors. A systems approach to maintenance training is being developed which integrates each element of training (initial technical training, on-the-job-training (OJT), field training detachment courses, MAJCOM formal training programs, career development courses, professional military education, and continued technical training). The HQ USAF/LE initiative, conducted under the project acronym "Rivet Train," welcomes new ideas. If you would like to suggest clear definitions of problems, propose innovative new ways of training, or offer your assistance, please write Lt Col Don Searles, AF/LEYM, Washington DC 20330-5130.

Biennial Thinking

JUNE 1986 PRESS ANNOUNCEMENT

Deputy Secretary of Defense William H. Taft IV announced today that the DOD would use its current review of the FY88 Defense Program and Budget to assess the requirements for the FY89 budget. Because this year's review will cover both FY88 and FY89, no program or budget review will be needed next year. The Deputy Secretary has directed that preparations for those reviews be stopped.

Seeing is believing! Air Force actually put two complete military construction (MILCON) justification books together, FY88 and FY89, and sent both to the Office of the Secretary of Defense (OSD) on 15 Sep 86. We want to thank the commands for their cooperation in this effort.

Since the *Biennial FY88/89 Budget Submittal* was announced in Oct 85, many of us had doubts that it would actually occur. Anything could happen to derail it, but everything right now is pointing to a biennial submittal to Congress. OSD, for example, has addressed our 15 Sep 86 Budget Estimate Submittal with equal detail and vigor for FY89 as for FY88.

There are several questions remaining and many people are busily searching for the answers. Although complete answers are not available, an Air Staff working group is busy identifying the problems of transitioning to the new system and we expect some guidance soon.

Meanwhile our best answers to the most common questions are:

Q. Will Congress actually accept the FY89 Military Construction Program (MCP) and review it like the FY88 MCP?

A. No one really knows. Remember, however, that Congress passed a law, the FY86 Defense Authorization Act, that requires the two-year budget. Some speculate the FY89 MCP will be returned by the Hill without action.

Q. Will Congress authorize FY89 only without appropriation?

A. This is a possibility, but it is not envisioned in the conception of the biennial budget. There is a new technique called Advance Appropriations which Congress used for a large Army project in FY87. In the FY87 MILCON Bill they made appropriations in advance for FY88 and FY89 to be available when those fiscal years arrived. Perhaps they could provide advance appropriations for FY89 when they approve FY88.

Q. Will there be a chance to change the FY89 MCP?

A. We believe there will be some mechanism developed to change FY89 to reflect Air Force missions and force changes and more accurately project costs based on design. Guidance will be issued when we have something definitive to say. In short, approval to make MILCON adjustments is probable. Meanwhile, keep reviewing your FY89 MCP and be ready to identify changes. Any changes, of course, will probably have to result in no total obligation authority (TOA) increase.

Q. Has the FY89-93 Program Objective Memorandum (POM) actually been canceled?

A. Yes, officially by OSD.

Q. Will there be some mini-program review instead of the POM?

A. It is almost a certainty that there will be. Air Force programming is too dynamic to lie dormant two years.
(Arthur B. Markowitz, Chief, Program Development Branch, AF/LEE)

"Within Lead Time" Changes

With the increased emphasis on reducing the budget deficit (Gramm-Rudman-Hollings) and limiting defense spending, the need to program our requirements in advance to ensure dollars are available is becoming increasingly important. For example, take war readiness spares kit/base-level self-sufficiency spares (WRSK/BLSS) authorization changes. A requirement for a new WRSK/BLSS must be identified and programmed a minimum of five years in advance of need. Anything short of that five years will result in unfunded, within lead time, changes which cannot be effectively supported logistically. The result is reduced support and lower C-ratings. The recent acceleration and beddown changes in the F-16 are a case in point. We will now be playing "catch up" in supporting this critical weapon system. In fact, in the new WRSK/BLSS authorization letter, 8 Dec 86, several authorizations are coded "for planning purposes only." This means that changes were made within lead time for which dollars were not programmed. The Air Force Logistics Command (AFLC) will load the kit for "programming" but will not procure or distribute any assets until dollars become available. When combining late requirements identification with less than full funding in WRSK/BLSS, the issue is further compounded. Bottom line: We must ensure requirements are identified early enough to be included in the programming process to allow for spares delivery in time to support the mission. (Kurt Jensen, AF/LEXW, AUTOVON 227-8812)

Interim Asbestos Policy

Whenever a building on an installation is to be reported for disposal, the potential exists that it may contain asbestos, whether as an insulation material, fire retardant material, or incorporated into other materials that are part of the building. Since unprotected exposure to asbestos fibers has been determined to significantly increase the risk of persons incurring certain gastrointestinal cancers, mesothelioma, lung cancer, and asbestosis, care must be taken by installation civil engineering personnel in their work (building maintenance or demolition) to avoid releasing or causing asbestos fibers to be released into the air, where they may be inhaled or ingested. Interim policy guidance for the disposal of buildings containing asbestos has been provided all MAJCOM civil engineers by HQ USAF/LEER. This guidance is being incorporated in a rewrite of AFR 87-4, *Disposal of Real Property*. (Charles G. Skidmore, Real Property Officer, AF/LEERA, AUTOVON 297-4033)

Public Highway Permits

The Air Force recently authorized transportation officers to request directly from state officials, permits for oversize, overweight, or other special movements over public highways by military vehicle. The responsibility to acquire necessary permits for commercial vehicle movements remains with the carriers.

The Directory of Permit Officials for Highway Movement contains state permit officials' addresses and telephone numbers. It also provides state size and weight highway limitations. Transportation officers should request inclusion in the directory and placement on distribution for future editions. Requests should be forwarded to the publisher: Military Traffic Management Command, Transportation Engineering Agency, MTT-TR, P.O. Box 62766, Newport News, VA 23606-0276. (Thomas Spade, AF/LET, AUTOVON 227-4742)

Unified Transportation Command

By memorandum of 1 Dec 86, the Chairman of the Joint Chiefs of Staff recommended the Secretary of Defense establish a Unified Transportation Command (UTC) to provide global air, land, and sea transportation to meet national security taskings. As proposed, the UTC will have three components—Military Airlift Command, Military Sealift Command, and Military Traffic Management Command—and will include the functions and responsibilities of the Joint Deployment Agency. The new unified command will focus on worldwide strategic mobility planning (deliberate and execution), automated data processing (ADP) systems integration, and centralized wartime traffic management. (Lt Col Tom Harrington, AF/LET, AUTOVON 227-7332)

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The C-141B Stretch Program: A Case Study of the Relationship Between the Military and Defense Contractors

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PART II

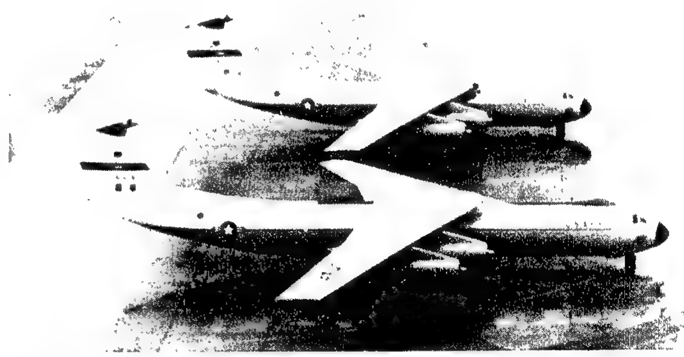
(This is a continuation of article published in Fall 1986 issue, AFJL)

The C-141B stretch modification contracts, although complex, enabled both sides to understand each other and permitted a tranquil production period.[40] While negotiations were underway, the contractual benefits were already being realized from the prototype testing program. Engineers, worried that the added length and weight might lead to performance and configuration uncertainties, discovered that the prototype (YC-141B) allowed precise verification of performance, handling, and flight profiles prior to production. Testing permitted modifications in design before production and minimized the likelihood of post-production changes. If the prototype revealed a need for design alterations, they were immediately introduced as engineering changes. In short, the prototype program enabled both Lockheed and the Air Force to get a better assessment of production costs for contract negotiations.[41]

Testing was divided into three phases. The first part of Phase I began in December 1975 at Lockheed-Georgia's leased facility at Dobbins AFB, Georgia, and culminated in June 1976. The Joint Contractor/Air Force Test Team took a typical C-141A (S/N 66-0186), with a service life closely representing the average fleet service life of 15,753 hours, and instrumented and tested it extensively to determine the general performance of all the Starlifters. Under detailed scrutiny, the unmodified aircraft flew 81 test hours and developed data to establish performance guidelines against which the same plane, modified into stretch configuration, would be compared.[42]

"The first modification problem arose when the YC-141B had problems during no-flap touchdowns."

During Phase II testing, the same C-141A was modified by adding the stretch modification package which included a 160-inch forward and a 120-inch aft fuselage plug, titanium reinforcing straps, new wing-to-fuselage fairing, and aerial refueling capability.[43] Work ended in January 1977 when Lockheed rolled out the new YC-141B prototype. The modified plane flew for the first time on 25 March. The Lockheed-Georgia Company and the Air Force Flight Test Center at Edwards AFB, California, conducted tests designed to reveal how the modification had affected the flight and transport capabilities of the C-141. Lockheed's portion of the testing, conducted at Dobbins AFB, culminated in June 1977 when the prototype flew to Edwards AFB, California. Here the aircraft underwent aerial refueling, aerial delivery, and other specialized testing. During Phase II, the first modification problem arose when the YC-141B had problems during no-flap touchdowns. On rare occasions when the airplane's flaps malfunctioned and could not be lowered, the pilot had to land without flaps. The extra 120 inches added to the modified Starlifter's rear fuselage put the tail dangerously close to the runway. By increasing airspeed five knots, the plane's tail stayed higher and cleared the ground safely.[44] The tail section and wing fillet problems both demonstrated the value of the prototype program because they settled potentially expensive issues before actual production began. After several long distance test flights, the YC-141B touched down again at Dobbins AFB on 28 July 1977, ending Phase II.[45]



Comparison of C-141A and C-141B. US support of the Yom Kippur War dramatized the need for our primary airlifter to fly, without requiring intermediate landings, to any point on the globe. The B-model modification provided not only in-flight refueling, but also added a 30% increase in cargo capacity.

Phase III testing, from August 1977 through May 1980, was less complicated. It tested aerial delivery of supplies and troops for the Army. The US Army, long a supporter of any move to lessen the strategic airlift shortfall, joined the Air Force and Lockheed in conducting tests at Edwards AFB and Pope AFB, North Carolina.[46] Supplementary tests were made to determine the maximum number of paratroopers that could be dropped safely from the modified aircraft. The YC-141B essentially performed like the Starlifter, except that extraction parachute line lengths had to be extended to enable heavy cargo to be pulled from the lengthened fuselage.[47] The Army had counted heavily on the C-141 for paratroop deployment. Army officials were anxious to see if the C-141B would perform as projected. Their special tests determined that, under contemporary airborne procedures, the maximum number of combat equipped paratroopers that could be prudently airdropped from the C-141B was 180 as opposed to the C-141A's 123.[48] The Army was satisfied with the results.

The final stages of prototype testing went smoothly. The project was on time and testing disclosed no additional

concerns. Generally, the entire effort up to this point had been a model of cooperation. The next step was the creation of a modification production line.

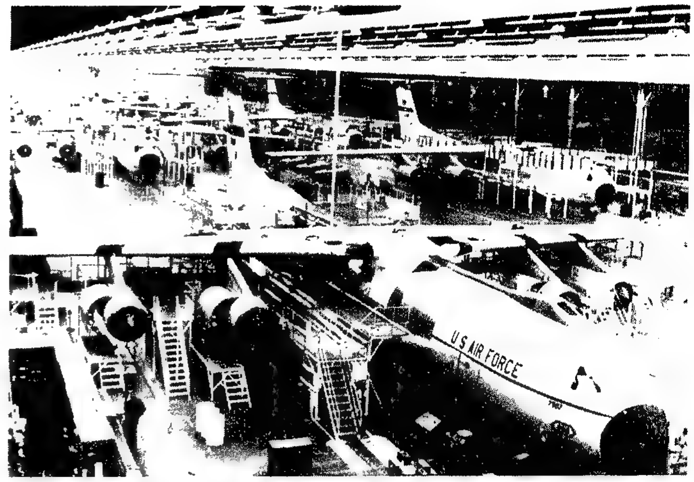
At Plant Six, Lockheed had, in one corner of the huge 76-acre structure, set up a disassembly line to separate the C-141A into forward, wing, and rear sections. The workmen used a double line for the first step of the modification. With the aircraft staggered in two parallel rows in the first nine line positions, the drooping wings of the C-141As crossed. Excluding the frontmost unit, each aircraft moved while touching the wing of the plane across from it.

> *"This plug location was chosen because it disturbed as little as possible the electronic and hydraulic systems."*

When the line reached peak efficiency in October 1980, it had to move every 2 1/2 days and each aircraft took exactly 64 workdays from arrival for total modification. In cases where parts did not arrive on time, the planes moved without them and were added later. After the ninth position, the aircraft shifted into a single line for the balance of the work. The separated transport moved along the line on air pads or jacks, clearing the floor by 1/16 inch, while a specially constructed rail system kept the parts aligned to within 10/1000 inch. New fuselage sections, again on air pads, slid in sideways where they were also attached to a precision alignment rail which kept the sections accurately positioned. Then the plugs were joined to the wing section. Parts and systems, which had been moved to facilitate modification work, were replaced and the aerial refueling system, with its special fairing, was installed on top of the fuselage.[49] Behind the wing near the mainframe and just forward from a compound contour fuselage area, a 120-inch plug, complete with all necessary fittings, slid into the separated fuselage. This plug location was chosen because it disturbed as little as possible the electronic and hydraulic systems. To match the plug's round, uniform cross section, part of the fuselage behind the separation point was modified slightly to conform to its substantial contours. Few of the rear wing fairings required alteration since their design remained unchanged.[50]

Choosing a location for the forward plug caused more concern. After prototype tests, it was revealed that Fuselage Station 618 was far enough ahead of the wing that installation of the 160-inch forward plug would have a minimal effect on the wing fairing and its systems. This station had been a secondary joint area during original production with all its stringers joining within 20 inches of the station. As with all installations of this type, the existing fuselage required some slight changes to fit it to the plug. The aerial refueling fairing required a few minor modifications for installation, while the forward portion of the wing fairing needed alterations to accommodate the fuel line cover. The first production C-141B rolled out on 4 December 1979.[51]

The functional 463L system cargo pallets which the plane could carry increased from 10 to 13, while the cargo volume increased about one-third from 7,019 cubic feet to 9,190 cubic feet. Translated into terms of mission productivity, these increases equaled 90 additional C-141As. This achievement was magnified by the fact that it was accomplished without any additional manpower requirements or operation costs. Moreover, additional aircrews did not have to be trained since the C-141B's flight functions remained essentially the same as



The modification production assembly line at Lockheed Plant Six. The use of an on-site Air Force detachment to monitor progress and deal with potential problems was a major innovation of the Stretch Program.

the C-141A's. Air Force studies estimated that the entire cost of operating all necessary C-141 servicing facilities at the six continental United States (CONUS) main operating stations would be only $1.5 million per year. The cost of modifications of the depot facility[52] at WR-ALC amounted to only $156,000.[53] Ground facilities at the six CONUS main operating bases required only minor length modifications to accommodate the C-141B.[54]

> *"The whole purpose of the modification was to increase the volume and bulk-carrying capability, not the weight transporting capacity, of the Starlifter."*

Notably, the production C-141B was actually lighter than the prototype due to a shift forward of the center of gravity and the deletion of the wing fairing.[55] Originally, engineers expected the modification to add about 10,000 pounds to the empty operating weight of the aircraft which would have reduced the maximum payload. However, continuing technical efforts by both Lockheed-Georgia and WR-ALC engineers resulted in a reduced increase of only 8,000 pounds. Eliminating the Lockheed fillet saved 1,500 pounds. Moving the front plug to a more forward location meant that less stress would be applied to the fuselage and a thinner, lighter aluminum could be used. This change saved an additional 500 pounds. Nonetheless, criticism of even this reduced weight came from some military leaders who maintained that the weight of the modification decreased the plane's cargo weight capacity. Yet the whole purpose of the modification was to increase the volume and bulk-carrying capability, not the weight transporting capability, of the Starlifter. The C-141A's problem had been that usually the cargo compartment was filled long before it reached maximum gross weight. In the rare instances where modified aircraft needed to carry heavier maximum cargoes than before, less fuel would be loaded to keep the entire plane below maximum takeoff weight. After becoming airborne, the aerial refueling capacity allowed the additional fuel to be added, making up for any loss of range caused by the stretched aircraft's additional weight.[56]

Perhaps the best example of the stretch modification's merit was the decrease in the number of missions required to fully deploy a combat unit in an objective area. On the average, the

C-141B required 20.8% fewer missions to carry Rapid Deployment Forces to their destinations. The average C-141A payload came to 21.9 tons, while the C-141B carried an average of 28.7 tons. Due to improved load distribution, the increased cubic footage allowed the C-141B to carry 23% of payloads that topped 40 tons, while only 3.6% of the C-141A payloads exceeded that figure. Although increased bulk capacity was the main goal of the stretch modification, its weight-carrying ability also improved in the vast majority of cases.[57]

One key lesson did not deal with technical systems or aircraft hardware, but with productivity management. During the preparation of the prototype, the WR-ALC's Stretch Program Office became aware of the importance of having regular personnel at the contractor's site. Many engineers and logisticians spent weeks on temporary duty (TDY) in Air Force Plant Six monitoring the Stretch Program. Day-to-day monitoring became even more necessary as the fleet production began. From an economic standpoint, permanent dispatch of some key Warner Robins personnel to Marietta for the duration of the project seemed to be a better alternative.

"In the old C-130 center wing modification, the contractor often received 3-5,000 hours per aircraft in 'over and above' work."

Stretch Program officers at Warner Robins developed a request to establish a special on-site detachment and processed it through HQ AFLC. In the fall of 1978, a group of six civilians—three structural engineers, one performance engineer, one logistics expert, and one procurement clerk—traveled to Plant Six. The group, together with the Air Force Plant Representative Office, began preparing for the problems brought on by modifying a fleet of airplanes an average of 15 years old. By relaying to the contractor all the various changes that had occurred on each individual aircraft, the detachment enabled Lockheed to better understand and prepare for the incoming C-141s, saving both money and time.[58]

Lastly, the detachment dealt with "over and above" expenses (necessary work discovered other than the work specifically called for in the contract) which most often led to the severest cost overruns. The government and the contractors could not always agree on just what work was needed. Nightmare memories of the old C-130 center wing modification, where the contractor often requested—and received—from 3,000 to 5,000 hours per aircraft in over and above work, reinforced the Stretch Unit's determination to keep over and above expenses absolutely under control.[59] With WR-ALC's detachment less than a ten-minute walk from the modification line, Lockheed could inquire about possible over and above problems and receive answers immediately. The plan worked. By September 1980, 60 C-141Bs had been produced and the average number of over and above work-hours expended on each plane was under 500 hours.[60] Scrutiny by Stretch Office Detachment members revealed that certain engineering specifications and basic work requirements, especially weighing the aircraft and alignment and symmetry checks, had little practical value. By eliminating these, the detachment sliced about $40 million in project costs. These savings alone far exceeded the cost of operating the Stretch Office Detachment.[61]

The detachment established major precedents which became as important as the modification itself. Its success was

"The on-site detachment concept may well prove to be the program's most important contribution."

measured, not by standards of engineering expertise, but by how much money its technical knowledge saved. Should future large-scale projects use this on-site detachment concept, it may well prove to be the Stretch Modification Program's most important contribution.

The production of the remodeled aircraft continued as the 1980s began. For the most part it was a smooth process. Once the engineers perfected the necessary techniques, the modification procedure was actually very simple. The Stretch Program officially ended during final rollout ceremonies held on 29 June 1982 at Lockheed's Marietta plant. The Assistant Secretary of the Air Force for Financial Affairs presided over the events. Representing the Secretaries of Defense and the Air Force, he called the project, "an attestation to the hard work and dedication of many people in the Air Force and at Lockheed."[62]

The Commander of MAC accepted from the President of Lockheed-Georgia, the symbolic key to C-141B serial number 63-8076, the 270th plane delivered to the Air Force by Lockheed.[63] The Commander praised WR-ALC's management of the C-141B Stretch Program and said, "This is a significant milestone in our nation's overall defense posture. The era of the C-141A ends today, but these 'gooney birds' of the 1980s usher in a new era in air mobility."[64] Lockheed-Georgia's president emphasized that "the key element of the story was the assignment of the program to Warner Robins Air Logistics Center."[65]

All the ceremonial rhetoric aside, the program was, from a purely quantitative standpoint, a success. The transfer of this fleet of aircraft to MAC marked the end of a successful partnership between the Air Force's (WR-ALC) engineers, managers, and technicians, and their counterparts from Lockheed-Georgia.[66] This effort modified 270 aircraft in five years, ended two weeks early, and was $20 million less than the final ceiling price with the final cost of the modification totaling $491.1 million for the equivalent of 90 new aircraft.[67]

"Good defense does not have to be excessively expensive."

The lessons of the Stretch Program have potentially far-reaching ramifications for the future of military procurement, military-civilian contract management, and cost effectiveness in the construction of new weapon systems. It is also proof that good defense does not have to be excessively expensive. Whatever may happen to the C-141B, the legacy of its creation should provide a blueprint for future weapon programs and the military relationship with contractors.

Notes (Cont)

[40]Contract Modification on Contract FO9603-75-C-0810 (P00001-P00056), 1978-1982.

[41]Kraus, Walter L., Jose M. Matheson, Joy Gustin, and Isobel M. Bryant, *C-141*, MAC/HO, 15 Jan 73, Ch. 1.

[42]Report by WRAMA/MMH, "Advance Procurement Plan," 26 Feb 74; SAB/IRT, YC-141B Prototype Status, I, Feb 77; Masterson Notebook.

[43]C-141B System Program Management Report by WR-ALC/MMSH, "Quarterly Highlight Summary," 31 Jul 81, p. 13 (hereinafter cited as Quarterly Summary 1981).

[44]For testing results see: Report by Maj Bryan D. Strickland, AFTEC YC-141B, and Maj Robert B. McCollough, AFTEC YC-141B, "YC-141B Operational Test and Evaluation, Final Report," Jan 78, 10-16; Trott Interview, pp. 1, 35-39. Col Trott was a pilot who flew a C-141A in Vietnam in the early 1970s. Later he was on the MAC staff as Assistant Deputy Chief of Staff for Logistics from 1975 to 1979. In May 1979 he replaced Col Litke as Commander of the Stretch Modification Office.

[45]Quarterly Summary 1981; Masterson Notebook.

[46]Quarterly Summary 1981; Report by Michael R. Wuest, AFTEC, Edwards AFB, California, "YC-141B Phase III Aerial Delivery System Evaluation," May 80 (hereinafter cited as Wuest Report).

[47]Wuest Report; Trott Interview, pp. 55-59; Quarterly Summary 1981.

[48]Quarterly Summary 1981; Report by Wuest, "Addendum I, YC-141B Phase III Aerial Delivery System Evaluation," Aug 80 (hereinafter cited as Wuest Addendum).

[49]Atkins Interview, pp. 15-20; Trott Interview, pp. 49-52; Report by Herbert M. Boyer, AFLC/DCS/MA, MMA, " 'Strawman' DCP for the C-141 Stretch Modification Program," 10 Jul 75, pp. 13-17.

[50]Feasibility Study by WR-ALC/XR, "C-141 Aircraft Stretch Modification Study," Briefings and Summaries, Vol. I-V, Jun 75 (hereinafter cited as Feasibility Study).

[51]Atkins Interview, pp. 18-19.

[52]One of the reasons it cost so little to revamp the maintenance facilities at WR-ALC was that the Air Force had spent nearly a million dollars in 1965 to redesign the same facilities to accommodate the C-141A.

[53]Report by WR-ALC/MMSH(2), "C-141 Stretch Integrated Logistics Support Plan Draft," Feb 79, pp. 36-45; PMP 1978, pp. 34-35; Masterson Notebook.

[54]Feasibility Study.

[55]Marco Study Report by MAC/XPSR, "C-141A & B Comparative Productivity Analysis," Jun 81, pp. 11-16; PMP 1979, pp. 16-17.

[56]Trott Interview, pp. 40-41; Atkins Interview, pp. 44-46.

[57]S & D Staff Report, "Fact Sheet, Recommendation No. III B2," May 80, p. 23.

[58]Atkins Interview, pp. 2, 5-7; Trott Interview, pp. 29-31; Quarterly Summary 1981, p. AI.

[59]Also performed by Lockheed-Georgia Company.

[60]Trott Interview, pp. 26-30; Atkins Interview, 8-9.

[61]Trott Interview, pp. 51-52.

[62]"Final C-141B Delivery 'Ushers in New Era,' " *Robins Rev-up*, 28:26 (2 Jul 82), p. 1 (hereinafter cited as Final Delivery).

[63]Office of History WR-ALC, *Annual History*, FY82, pp. 60, 68 (hereinafter cited as FY82 Hist); Final Delivery, pp. 1, 12.

[64]FY82 Hist, pp. 68-69; Final Delivery, p. 12.

[65]FY82 Hist, p. 69; Final Delivery, p. 12.

[66]The secondary contractors included: Parker Hannafin Co., Irvine, California (fuel receptacles), and Brooks and Perkins Co., Livonia, Michigan (cargo rails and rollers).

[67]Final Delivery, p. 12; FY82 Hist, pp. 68-69. The final FY81 cost estimates for the prototype came to $37.5 million, while production required $473.8 million for a total of $511.3 million or $1.89 million per plane. The actual final price was $491.1 million or $20.2 million less than the contracted price.

▶ FROM 16

Business Strategy Panels (BSP)

The specific purpose of a BSP is to convene an early planning session to develop a systematic and disciplined approach toward achieving an economical, efficient, and effective acquisition. The BSP is composed of knowledgeable functional experts (including logistics) who discuss and recommend applicable acquisition strategies for a specific product or service. The BSP operates in an advisory capacity. The primary objectives include emphasis on competitive contracting procedures throughout the program and the increased awareness of the need for logistical planning, including spare parts, in the source selection process. Typical logistics issues discussed at a BSP include contractor support, life cycle cost (LCC) application, spare parts planning, technical data, test equipment, warranties, and training. (Norm Rappaport, AF/RDCS, AUTOVON 227-7714)

Toward Balanced Logistics Capability

In the current world of limited funding, the Air Force is constantly faced with the critical decision of how to best allocate dollars to achieve maximum wartime capability. Decisions can no longer be made on an item or commodity basis (e.g., fill rates and backorders) without full consideration of the impact these decisions have on the readiness of weapon systems. To manage limited resources efficiently, the Air Force is developing a means whereby limited materiel investment funds can be programmed and executed more effectively to achieve a balanced materiel readiness posture. As a short-term solution, problem items for the Weapon System Management Information System (WSMIS) will be provided to the managing air logistics centers to identify the items that provide the most war-fighting capability. As a mid-term solution, WSMIS and the Requirements Data Bank (RDB) propose to join forces in an effort to prioritize wartime requirements for buy and repair. As a long-term solution, RDB/WSMIS will provide the capability to determine requirements by weapon system, apply limited funds by priority, and assess the wartime capability gained/lost from allocation of dollars. (Ms Shirley Davis, AF/LEXW, AUTOVON 225-2793)

Source Selection Guidance

A new source selection publication, AFR 70-30, *Streamlined Source Selection Procedures,* will shortly be available for use by all MAJCOMs and will include streamlined procedures to take the activity from the acquisition plan to contract award. Currently, AFR 70-15, *Source Selection Policy and Procedures,* sets source selection policy for major programs and projects for which the Secretary of the Air Force is the source selection authority. AFR 70-30 is consistent with the policies of AFR 70-15; however, it encourages each MAJCOM to tailor the process for its own individual project requirements and organizational application. The principal objective is to select an offeror whose proposal has the highest degree of credibility and whose performance can best meet the government's requirements at an affordable cost. The areas to be considered in evaluation include logistics as well as technical, management, cost, and other evaluation criteria. (Norm Rappaport, AF/RDCS, AUTOVON 227-7714)

Most Significant Article Award

The Editorial Advisory Board has selected "Vietnam Logistics—Its Meaning for Tomorrow's Air Force" by Brigadier General (Maj Gen Selectee) Edward R. Bracken, USAF, as the most significant article in the Fall issue of the *Air Force Journal of Logistics*.

Technology and the American Way of War: Worshiping a False Idol?

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IRA C. EAKER FIRST-PRIZE ESSAY

For much of the past century, the American military has been in headlong pursuit of technological solutions to its war-fighting problems. As the pace of scientific progress accelerated in the second half of the twentieth century, ever-more sophisticated gadgetry and its presumed battlefield advantages became prime objects of American research, development, and acquisition efforts. This effort to substitute American wizardry for American blood has met with enough success that, to a large degree, technological "force multipliers" are now the preferred currency of the American military realm. High tech has become the American way of war.

There is no question that pursuit of high-tech weapon systems has produced capabilities undreamed of only a few decades ago. Whether we look at ground, sea, or air forces, the story is the same: weapon systems are faster, more powerful, and more accurate. It is no wonder many among us have come to believe that technology has almost mystical powers to provide panaceas. To at least some degree, we have been seduced by technology's legendary successes and glittering promises. But a note of caution should temper the nearly frantic pursuit of high-tech solutions. Although modern technology is important to success on the battlefield, its impact can be overstated, its risks understated, and its opportunity costs obscured or ignored. In short, although we must not stifle technology, we must bring the science of war into better balance with the art of war.

If we examine the relationship of technology and warfare with a skeptic's calculating eye, we can find several factors which should at least provide a cautionary note to the pursuit of high-tech solutions. An examination of these factors is a worthwhile exercise for we must assure that any force multiplier has a value greater than 1.0. Anything less is self-defeating.

Squandered Advantages

British - World War I

Technological advantage has often been skillfully exploited to yield decisive results in battle, even when the technology was new and previously untried in combat. The British, for example, were very successful in exploiting their new radar system in conjunction with the overall air defense plan in the Battle of Britain. However, **superior technology does not guarantee effective use** of that technology. The history of modern warfare is replete with examples of squandered technological advantage. During World War I, for example, the British developed the tank which had the potential to break the bloody stalemate on the Western Front. But the British required nearly two years of experimentation before they learned how to use tanks effectively. This example is particularly enlightening because primitive tanks did not represent a significant leap in technological sophistication. Rather, they were simply a new combination of well-known technologies. It is perhaps even more important that the British squandered their hard-won advantage by forgetting or ignoring the lessons they learned in World War I. Ironically, the Germans, who had all but ignored tanks during the first war, learned their lessons well and excelled in armored employment during the second war.

Germans - World War II

Later in World War II, the Germans failed to capitalize on their advantages in jet and rocket technologies. Had the Germans concentrated their efforts on the production of jet-powered interceptors, the Allied strategic bombing offensive might have been in jeopardy. In the same light, had the Germans targeted their V-1 and V-2 weapons against embarkation ports in Great Britain, they might have seriously disrupted the logistical effort required to sustain the Allies on the Continent. Instead, the Germans concentrated on jet-powered attack bombers and rockets used as vengeance weapons against British cities.

US - Korea and Vietnam

In a slightly different sense, the United States (US) wasted its overwhelming technological superiority in both Korea and Vietnam. In both wars, military leaders found some of their most potent weapons could not be used for intended purposes because of political considerations. The conflict in Vietnam was particularly frustrating because vastly-superior American technology was, in the long run, largely irrelevant to the outcome of that forlorn war.

Perishability

Technological advantage can be a decisive factor in battle just as radar provided an important advantage for the British in 1940. But given enough time and resources, technology can be equaled by the enemy as our bomber crews learned when they attempted to penetrate German airspace later in the war. Technological advances are based on the physical laws which are well known to our most dangerous opponents, particularly in the age of the information and communication explosions. In effect, there are no real technological secrets. Even if our opponents do not have the scientific, economic, and industrial infrastructures to produce equal technology, they can often obtain sophisticated weaponry from allies or supporters. The

important point to remember is that technological advantage is a relative thing. If an enemy develops or acquires equivalent technology, the advantage disappears and force multipliers no longer multiply.

Technology can also be countered in one of two ways. The most obvious method is through the use of a countering technology. It is particularly frustrating that some countermeasures are simple and inexpensive, as well as effective. For example, chaff—simple strips of tinfoil—was first used to counter radar in World War II. It remains an effective counter to this day. Simple flares are often used effectively to "spoof" sophisticated heat-seeking weapons. Nowhere is the technology-countering capability more apparent than in the realm of electronic warfare. Electronic devices quickly yield to electronic countermeasures and in turn to electronic counter-countermeasures.

The second method used to counter superior technology is through the use of clever strategy and tactics. A mastery of the art of war can offset, if not nullify, technological advantages. The US learned this lesson most recently in the Vietnam struggle. The US went to war in Southeast Asia relying on sophisticated weapons which could deliver large amounts of fire and steel on almost any target. During a major portion of the war, the enemy countered by using guerrilla strategies and tactics. They eliminated lucrative targets by working in small units, by refusing to stand and fight, and by hiding among the civilian population whose allegiance was critical to the American cause. When the enemy departed from these tactics, such as during the Tet Offensive in 1968 or the Easter Offensive in 1972, they paid a bloody price and suffered crushing defeats.

Battlefield Performance

The dazzling successes of our sophisticated weapon systems can obscure the fact that **technology may not perform as well as expected.** Fortunately, our combat experience is infrequent. But this blessing often means that many of the high-tech gadgets upon which we have come to depend are untested in the rigors of combat. In spite of our best efforts, neither simulations, exercises, nor maneuvers can replicate the chaos, complexity, and terror of the modern battlefield. We often find it difficult to anticipate the counteractions of a clever and dedicated enemy. The result is that we are frequently confronted in war by unexpected circumstances which can seriously hinder the effective employment of weapon systems and reduce or nullify technological advantages.

Perhaps the classic airpower example of the problem is found in the American planning for the strategic bombing campaign in World War II. The accuracy predicted for bombers was based on careful experiments conducted before the war. Unfortunately, the calculations of the planners included the hidden assumption that each bomb dropped was individually aimed at the target. In truth, entire bombloads were jettisoned by a single command from the bombardier. Even worse, because of unanticipated difficulties peculiar to the aerial battlefield, entire bomber formations often dropped their bombs on the command of a single lead bombardier. In some cases bombsights were removed from all but the lead and deputy lead aircraft in a bombing formation and replaced with improvised mounts for defensive guns. As a result, in spite of a generous "fudge factor" included by the planners, their calculations were seriously in error—calculations which affected the entire strategic bombing program from bomber procurement to damage expectancy.

Even if it works precisely as expected, **technology may not produce a decisive advantage.** For all their wonders, technological improvements in weapon systems tend to be evolutionary rather than revolutionary (with a few notable exceptions). In other words, technology tends to operate at the margins of military effectiveness. Technology provides soldiers in the field with "better" targeting systems, "more accurate" weapons, and "more powerful" explosives. Certainly these weapons are better, more accurate, and more powerful. Just as certainly these improvements are important. But, they may not produce a decisive advantage. Even if the technological advantage is large, it still may not be decisive because of any or all the factors discussed earlier.

Unwanted Baggage

Technology has increased military capability immeasurably. However, there has been a price paid for every advance in capability. There is no free lunch. It is clear that **technological sophistication produces unwanted baggage**—undesirable side effects which offset, to some degree, the advantages produced by technology. This baggage must be evaluated when we examine the net worth of a force multiplier. The baggage comes in several varieties.

High cost is the most obvious piece of unwanted baggage. The cost of modern weapon systems is breathtaking by almost any measure. This is not to say they are not worth the price. By almost any measure they are "better," "more accurate," and "more powerful" than any similar weapons previously fielded. However, their incredible cost virtually guarantees we will produce relatively few of these weapons. This problem, of course, is at the heart of the quality-versus-quantity issue. Those who favor the latter argue that quantity has a quality of its own and that technology cannot forever offset the superior numbers which may be fielded by our opponents. The price of high-tech weapons can also be critiqued in terms of opportunity costs, those things we forego to pay for the acquisition of expensive gadgetry. The acquisition of new weapon systems comes, to at least some extent, at the expense of more mundane needs such as spare parts, munition stocks, training sorties, and support equipment.

The cost of sophisticated weapons leads to another major problem. The cost of some of the most sophisticated "smart" weapons dictates that they cannot be expended in training. The Army, for example, finds it difficult to conduct frequent live-fire training for the bulk of its troops with the most expensive anti-tank missiles. The Air Force faces somewhat the same problem with its sophisticated air-to-air missiles. Such predicaments exacerbate the problems of effective employment and battlefield performance. The development of advanced simulators attacks this problem but does not solve the problem. Some might argue that modern technology has made these weapons so simple and reliable that little training is needed. Those possessing the skepticism born in combat experience know better.

A third piece of unwanted baggage reveals the two-faced nature of some technological developments. On one side of the ledger is rapid field repair based on the concept of removing and replacing "black boxes." On the other side is the fact that repair of the black boxes may require delicate equipment

available only at central depots located far from the battle area—a situation of questionable merit in high-intensity, rapidly-changing combat situations.

Munition consumption is another example of the two-faced phenomena. On the one hand, "smart" weapons can accomplish with one bomb or missile what might require many hundreds of "dumb" weapons. On the other hand, the appeal of some modern weapons is found in their incredible rates of fire. These weapons, used by nearly everyone from ordinary infantrymen to high-flying fighter pilots, consume munitions at an incredible rate, dwarfing anything seen heretofore. They can put a considerable strain on any logistics system and magnify any shortcomings in munitions stocks (some of which may have been created in the first place by cutting corners to procure the basic weapon system). Even more than in the past, the decisive factor in warfare may not be in the quality or quantity of weapons or even in the skill with which they are used. Rather, the key to victory may well be found in the ability to supply adequate consumables to troops in the field. Ironically, warfare's newest weapons have magnified the importance of one of warfare's oldest requirements—superior logistics.

Balancing the Scales

The foregoing list of potential and actual problems should cause even the most ardent technocrats to at least pause and reflect on their passion for sophisticated weaponry. To some so-called military reformers, the list might also seem to confirm dark suspicions regarding the superiority of quantity over quality. As one might expect, the most rational reaction to the list lies someplace between the views of the anxious technocrat and the dour reformer.

It should be clear to almost any serious student of military affairs that, other things being equal, superior technology on the battlefield offers significant advantages. It is also demonstrably true that when other things are not equal (which is almost always the case), superior technology can play a significant role in leveling the odds on the battlefield. However, these truths must be tempered by the thesis of this essay, which is that a militarily significant technological advantage is a fragile, perishable, and elusive commodity.

With all of this said, what is to be done? We face a future that seems to compel an accelerating rush toward more and more sophisticated weapon systems. Ensuring that these weapons do, in fact, increase our military capabilities, in spite of the factors which might militate against such increases, will be a difficult problem. Three approaches to the problem may yield favorable results. The first approach is rather obvious and the second less so. The third approach is quite subtle but perhaps the most important.

First, we must restrain what has become a natural enthusiasm for the leading edge of technology. The skeptic's eye is a useful and revealing tool. We should keep in mind the admonition that if it sounds too good to be true, it assuredly is. We must develop a method that weighs opportunity costs and the risk of failure against the possible advantages of new weapon systems. As we consider those advantages, we must also look long and hard at how they can be effectively exploited on the battlefield and, conversely, how an opponent might counter those advantages. And amid the glitter of high tech's bells, whistles, and flashing lights, we must pay attention to the mundane logistical details that may ultimately determine victory or defeat. In short, we must assure that any presumed force multiplier actually multiplies capabilities by a factor of more than 1.0.

The second approach is somewhat of a mirror image of the first. Although Americans take great pride in a tradition of technological superiority, our principal potential adversary also places considerable reliance on sophisticated technology and faces similar problems as a result. Thus it would seem prudent to spend considerable energy learning how to exploit the internal problems created by the enemy's technological success. In the past we have viewed the enemy's technology only as a threat and generally ignored the problems—for him—that the enemy's high-tech weapon systems engender. As just one example of possible enemy vulnerabilities, the munition consumption rate of modern weapons probably exacerbates traditional Soviet logistical weaknesses. The exploitation of these weaknesses could lead to effects out of all proportion to the effort expended. With further study, we might identify several technology-inspired vulnerabilities that we can effectively exploit. To do this, however, requires that we develop a mindset that regards technology as a two-edged sword.

The third approach to the problem is much less obvious. The basic assumption we live with assumes that the US possesses the superior technology, which is a proposition of questionable validity. We must not be so seduced by the promises of modern science that we ignore the time-honored study of the art of war. Skillful strategy, clever tactics, and practical doctrine will help us exploit any technological advantage we possess and may save us if our technology fails or if we find ourselves in a technologically inferior position. The ideas of Clausewitz and the other masters of the military art are pertinent even in the era of electronic counter-countermeasures. The spectacular advances of military science have not obviated the importance of understanding the art of war.

If anything, the need to understand the art of war is magnified by the revolution in military technology. Unbridled enthusiasm for high-tech solutions tends to be infectious, producing a disease that destroys historical perspective. The high-tech contagion can make us forget that how we use what we have is often more important than what we have. If the American officer corps ignores the art of war and concentrates on finding technological panaceas, it will relinquish the formation of strategy and the development of tactics to those who know little about war and nothing about combat.

Technology is important, but it is not a panacea for our military problems. It must be pursued and exploited but with caution and skepticism. We must use technological advantage skillfully and at the same time be prepared to counter a possible enemy advantage cleverly. We must remember that the science of war complements rather than replaces the art of war. We must remember that technology is a tool of war, not a way of war.

With all of this said, we return to the question posed in the title of this essay. Is technology a false idol? Probably not. It might be better described as fickle—dispensing its favors to those who regard it skeptically, develop it carefully, and use it wisely.

The *Air University Review (AU Review)* awarded this article first place in its annual essay competition. *AU Review* graciously offered first publication to *AFJL*.

READER EXCHANGE

Rx

TECHNOLOGY, LOGISTICS, AND AIR DOCTRINE

The articles concerning the need to "restore air power's flexibility" *(AFJL,* Summer 1986) certainly underscore the dilemma confronting our tactical air arm as it readies itself for the twenty-first century. The dilemma is the acquisition of extremely expensive aero-weapons that are very sophisticated and marvels to behold but whose reliability for day-to-day operations is less than desirable.

The implication is that technology has brought us to an impasse wherein our air arm is becoming less effective because the avionics durability is limited and requires a vast supply and maintenance structure to keep it operational. Our concept in employing tactical squadrons requires that aircraft will have a maximum sortie rate and that nonbattle-damaged aircraft can be turned around for another sortie without aborting to avionics or computer failure.

The underlying cause of this dilemma cannot wholly be blamed on technology—we have encouraged the development of those weapon systems by allowing our love affair with technology to dictate air tactics rather than tactics determining the structure of the weapon systems. The dazzling array of electronic wizardry developed by the arms industry has blinded policymakers so that developing super-sophisticated arms has become an end in itself, rather than developing tools of war that will bring success to our military endeavors.

The best way for the Air Force to get on track as to what type of aero-weapon to develop is to have a professional cadre of critics (civilian and military) evaluate past wars, battle, and military engagements in terms of their success and failures; the weapon systems employed; the role the air arm played; and how well systems achieved their missions or goals. Had this been done after World War II, Korea, Vietnam, and particularly the Arab/Israeli conflicts, a better definition of how to employ aero-weapons could have been determined. Had this been done, good practical weapon systems would have evolved that are effective in all environments.

Too much of our present predicament is the result of past decisions based on air doctrine/policy that has not proven itself. Past air power visonaries, such as Mitchell, Spaatz, Foulois, Arnold, and Eaker, left us a mess as well as a rich heritage. To avoid these kinds of predicaments in the future, we should junk "air doctrine" because it does little but stifle innovative and creative thinking and block the execution of sound military action.

The most erroneous idea or doctrine our visionaries gave us was that air power alone could win a war. The truth is that aero-weapon systems are tools best used to support land army battles. We won World War II with the *help* of air power, yet lost the Korean and Vietnam wars with air power that was virtually unopposed and the most powerful the world had seen to that time.

Apologists for air power say their position is vindicated because Japan was defeated during World War II by air power and the atom bomb. Little do they realize the same result would have been achieved if the US Navy had detonated the bombs from floating platforms in the harbors of Hiroshima and Nagasaki.

The Israeli-Arab conflicts of 1967 and 1973 ably demonstrated the correct use of the aero-weapon system, which was to support the ground battle. It was only when the ground battle was over that the Arabs had been militarily defeated. Yes—the Israelis used their aero-weapon systems to destroy the Arab Air Force, but they did it for the most part by putting it out of commission on the ground. They did not waste their resources or prolong the war by going through the various doctrinal steps of air defense, air superiority, strategic bombing, air interdiction, and finally ground support.

Air power advocates to the contrary, the war does not cease when the air battle is over; it waits until the ground battle is done. This is why our air power has not been as effective as it could be. During World War II, Vietnam, and Korea, the Air Force all too often went out over enemy territory doing its own thing (air doctrine calls this *interdiction).* One of the problems with this philosophy is the enemies learn how to accommodate it, because they have time to develop ways to work around the disruption we have caused to their communications and supply lines.

In Vietnam, we had all the air doctrine and the latest aero-weapon technology in our favor. How could we *not* win when basically all the enemy employed was a rifle-toting foot soldier. It was a classic example of the epitomy of technology versus the standard war weapon (infantry). We blew up a lot of real estate, defoliated a lot of jungle, killed a lot of noncombatants, sacrificed a lot of American men—and watched all our efforts end in vain. The bottom line is that high technology and fancy gadgetry primarily benefit one person—the supplier. Our resources in future wars should be directed against the enemy and not consumed in trying to overcome the pitfalls of high supply and maintenance costs associated with high technology.

Do we pursue this relentless goal of making our tactical aero-weapons so sophisticated and complicated in anticipation of war with Russia? War with them is not likely because nuclear missiles will continue to prevent it. The possibility of war for us will most likely occur in under-developed third world countries. The wars and military actions we have engaged in since World War II have been of this type. What advantage will we have in employing the F-15, F-16, and ATF aero-weapons against an enemy whose technology is geared to hand weapons?

The only way to have aero-weapon systems that are reliable and effective is to design them that way. That means keeping the avionics to an absolute minimum. We should concentrate our efforts on making airframe and engine systems reliable and durable. In consonance with this concept, ordnance avionics should be limited to keep it reliable, durable, and hard-hitting.

The aero-weapon I have described would really serve our needs better for several reasons. The available sortie rate would increase significantly. Sortie turnarounds would take less time and acquisition and supports costs would be dramatically reduced. These aero-weapons would be more effective because the monies saved could be used for more training to increase the proficiency of the pilot.

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BREAKING INTERSERVICE BARRIERS

Congratulations on the best issue of the *Air Force Journal of Logistics* yet published. I found all the articles interesting and pertinent. I particularly enjoyed the article "Logistics for the Fighter Wing of the Future" by Major Leach, since he did not allow the realities of the present (which should be viewed as challenges to be met instead of impediments to progress) to limit his thinking about the possibilities of the future.

One of the improvements suggested in the article "Taking Microcomputers to War: What Transporters Have Learned" by Capt Wasem was: "A standard method or procedure to gather information on critical locally available resources is needed." This suggestion is indicative of a systemic barrier to efficient and effective use of military resources/combat power; namely, a reluctance for interservice sharing of information and unrestricted cooperation. If such was not the case, Capt Wasem would have known that the US Army Logistics Center has for some time been developing just such a methodology. Their program is called *Locally Available Materiel/Services (LAMS),* which uses LOTUS 1-2-3 spreadsheet templating "to assist planners in obtaining locally available materiel and services within a given area of operation." This program is an extension of the Army's operational concept of using locally available materiel and services to meet a portion of a contingency force's requirements. While the program is still maturing, it has been used by the 193rd Infantry Brigade Contracting Division to gather and access data about contractors in Honduras. Copies of the program can be obtained by writing to US Army Logistics Center, ATTN: ATCL-OPF (Maj Burmood or Capt Devies), Ft Lee, VA 23801-6001, or calling AUTOVON 687-1628/2325/3813.

My biggest challenge in my current billet has been just such a sharing of information between Army and Air Force logisticians. We all can learn from each other and should eagerly seek out every opportunity to share information and cooperate in all areas of mutual interest. Unfortunately, such sharing and cooperation seem to be the exception rather than the rule as we wrestle with the day-to-day challenges of logistics. There are high-level initiatives, such as the JCS-sponsored Joint Logistics Techniques and Procedures Board and joint logistics doctrine development effort, which attempt to break down the existing systemic barrier to information sharing and cooperation. However, this barrier can only be removed when all logisticians actively seek out their counterparts, no matter what color their uniform, and jointly attack those day-to-day logistics challenges.

Again, thanks for the informative and useful issue of the *AFJL*. I have passed it to all my Army contacts and have suggested they subscribe to the *AFJL* themselves. Keep up the good work!

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Contracting Out: Problems for the Unprepared Mid-Level Manager

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Have you heard the expression that the contractor with the lowest bid always gets the contract? Have you heard of any "less than harmonious" dealings with civilian contractors? Would the prospect of selecting and managing a contractor to do your own job cause any degree of "high anxiety"? Let me pose a scenario. Let us say that I am your supervisor and you are a mid-level manager. Your task is to have the XYZ service function converted from military to contract performance as soon as possible. How would you feel and how would you begin?*

This scenario is occurring more and more often in today's Air Force. If you are a mid-level manager like me, then perhaps your reactions would be the same as mine—I did not have the slightest idea how or where to begin such a task. Perhaps you would feel as I did—that the Air Force has been remiss in preparing us to assume a project of such magnitude. One purpose of this paper is to convince the reader that the Air Force is not preparing mid-level managers for their responsibilities in the base-level services contracting process. The other purpose is to help fill some of that void by passing on some insights learned the hard way. We will look at three basic areas in order to fulfill these objectives.

First, some background to "contracting out" is in order; it is important to know why we contracted out in the past and why we shall continue to do so in the future. Second, we should understand that mid-level managers themselves contribute significantly to problems within the contracting arena. Finally, we will take a look at the multitude of responsibilities placed upon mid-level managers. We will conclude by posing several solutions to assist these managers through more education and regulatory guidance.

Why Contract Out?

The cornerstone of American society and the tradition upon which the United States was founded is free enterprise through competition. The competitive enterprise system, characterized by individual freedom and initiative, is our primary source of national economic strength. (5:1) In order to protect this system, federal policy ensures the government does not compete with its citizens. The Department of Defense and the Air Force are bound by Office of Management and Budget (OMB) Circular A-76, Performance of Commercial Activities, to guarantee competitive selection of their products and services, either from the civilian sector or "in-house" by the military. However, the Air Force retains the option of using strictly military or civilian personnel when national security necessitates or when "in-house" assets are essentially the only means to perform the service. (7:1,2,4;4:1) In addition, cost savings are a major factor in determining whether the civilian sector or military assets are used to perform required services.

With the implementation of Public Law 99-177, commonly referred to as the Gramm-Rudman Balanced Budget, the incentive to keep operating costs within allocated funding and manpower ceilings has become paramount. However, defense manpower costs continue to consume over 50% of defense outlays despite significant reductions in military and federal civilian end strengths. (2:1) As a result, an Air Force study anticipated that Congress will mandate even more contracting out and that by the 1990s there will be a 100% increase in the total number of major base services contracts. (16:5,7) The decision to contract out is usually made after an in-depth cost comparison analysis has been performed in accordance with OMB Circular A-76 and Air Force Regulation 26-1, Volume 1, *Manpower Policies and Procedures Comparative Costs Analysis*. (12:1) Furthermore, the decision to contract out does not always result from cost comparisons, but can occur due to major command (MAJCOM) policy, base or unit mission changes, or the need to support new programs. Regardless of the rationale, contracting out has generally been a success story for the Air Force.

"Although successful, contracting out is maligned, viewed with skepticism, and adamantly opposed by all levels of Air Force leadership."

Since Fiscal Year 1979, the Air Force has completed 550 OMB Circular A-76 cost comparison analyses of various base support functions. Nearly 70% of the work-years reviewed were converted to contract. A follow-up of 132 contracts revealed that, even with increased contracting costs, there was an average 33% cost savings from contracting over in-house performance of the activity. (8:44) Although it has proven successful, contracting out is maligned, viewed with skepticism, and adamantly opposed by all levels of Air Force leadership.

Management's Perceptions

Misconceptions and opposition to contracting out are perpetuated by Air Force managers. They feel they lose control, flexibility, and responsiveness, and that—because of the misconception that the lowest bidder always gets the contract—we get only what we pay for. (2:247-258) Managers gain these attitudes, perceptions, and oppositions from commanders and supervisors. They will most likely pass them

*Taskings come to taskees in many ways. The supervisor may have been more precise by specifying that "an A-76 evaluation will be performed within an appropriate timeframe." However, the author expressed the tasking in a manner frequently encountered by mid-level management in the "real world."

on to those who follow, to the detriment of the contracting process. On the other hand, some of these misconceptions may have been gained through exposure to bad experiences in the contracting arena.

In 1983 an Air Force Audit Agency project identified several discrepancies in contracts that fueled managers' misconceptions. The project reviewed 31 contracts let in 1980. It found that 15 of those contracts had required modifications to their Performance Work Statements (PWSs). The PWSs were changed because of subsequent events, errors, or a combination of the two. The end result—$3.8 million in contract costs over original estimated amounts—can be attributed to the mid-level managers who originally prepared the PWSs and surveillance plans. Although the services were performed under each of these contracts, they certainly were not accomplished within the originally projected costs. (18:2,5,6) These instances certainly perpetuate contracting opposition. But, more importantly, they demonstrate that mid-level managers were not adequately prepared for their responsibilities in the contracting process.

Mid-level managers are the principal driving force behind any initiative to change an idea or task into a comprehensive, quality, operational contract. In this process, mid-level managers are commonly referred to as "technical authorities" in their area of expertise. As such, it is their responsibility to:

(1) perform a job analysis (as it is being done by the Air Force or as a contractor would perform the function) to determine what actually results;

(2) prepare the PWS that accurately describes the essential and technical requirements for items, materials, or services, including the standards used to determine whether the requirements have been met; and

(3) create the surveillance plan which contains sampling guides, checklists, and decision tables to measure contractor performance. (10:Ch 1-4)

These responsibilities appear straightforward. However, what happens when mid-level managers approach them along with their misconceptions, opposition to contracting out, and lack of experience—while simultaneously performing normal day-to-day duties?

The Manager's Dilemma

To begin with, the mid-level manager is labeled the "technical authority" and must therefore perform a job analysis. The "technical authority" is confronted initially with the fact that military jobs are not documented routinely in individual job descriptions/breakdowns like civilian position descriptions. So, the job must be started from scratch. The mid-level manager soon realizes and acknowledges that the title of "technical expert" belongs to the first line supervisor.

First line supervisors are involved in the "nuts and bolts" operation of the job. Hence, the mid-level manager and first line supervisor, working together, create the necessary contracting documentation. They are obligated to use the "systems approach" to identify all facets of the job and to summarize how the tasks fit together as an operational system. Sounds easy, but:

> The analysis assumes that an operation is a system. An operation can be called a system because it consists of a job, or a combination of jobs, carried out by people, and sometimes machines, for a certain purpose. The parts of a system are usually called input, work, output, and control loops. (10:1-2.1)

Several Air Force regulations provide "general" guidance on how to conduct a job analysis using the systems approach. But the bottom line is that every job must be analyzed individually and it is no easy task!

The mid-level manager is responsible for documenting all task items, including measurable parameters, to ensure that a contractor is performing as required. Again, the first line supervisor is the logical source of explicit information. The manpower standard, if one exists, is of little help. These standards contain only generic job descriptions and therefore are basically useless in defining local tasks. (11:Ch 1) Assuming that the job analysis is successful and specific performance indicators have been identified, the mid-level manager can then begin drafting the PWS. (10:Ch 2) This is a true statement, but one that illustrates a further problem with guidance now available.

Many associated factors must be reviewed before any of the contracting documents are initially drafted. These factors have not been included in regulatory guidance available to the mid-level manager. Factors such as host-tenant relationships, long-range programs or schemes, logistics support/payment/interface, security requirements, facility use, and utility reimbursements are factors that have direct impact on any contracting situation, but they are only reviewed if the "technical authority" has experience in these matters or something "rings a bell" bringing the items to mind.

"Mid-level managers are 'rookies' in the contracting process."

Experienced or not, the mid-level manager can expect to make many visits to both the servicing management engineering team (MET) and local contracting office before the contracting documents, PWS, and surveillance plan are acceptable. In fact, it is not uncommon for the documents to be rejected numerous times. (3) More often than not, the rejections occur because of insufficient data, poorly written PWSs which contain undefined terms or improper legal terminology, or poorly constructed quality control surveillance plans which lack specific, measurable performance standards. (18:6) These instances illustrate that the contracting process is staffed by contracting specialists, assisted by manpower experts, reviewed by legal authorities, but *handicapped* by "unprepared" mid-level managers who assume the role of "technical authorities." They are "rookies" in the contracting process.

Bridging the Gap

The Air Force has not taken steps to educate its personnel concerning the misconceptions and sometimes opposition to contracting out that permeates through the corps. Education to reduce opposition should be the first move. The notion that the lowest bidder always gets the contract needs to be dispelled through education. Certainly, the lowest bid is the most publicized reason for vendor selection, but we need to educate our mid-level managers that a vendor must bid low plus:

> (1) have adequate financial resources, (2) be able to comply with required delivery or performance schedules, (3) have a satisfactory record of performance, (4) have a satisfactory record of integrity, and (5) be otherwise qualified and eligible to receive an award under applicable laws and regulations. (5:5)

Moreover, we must concentrate our efforts toward providing education in order to prepare mid-level managers for all their responsibilities in the contracting cycle.

Every year the Air Force spends millions of dollars on professional military education (PME) for its mid-level managers, but hardly any of the education is focused on the contracting area. To begin with, Air Force Pamphlet 50-34, Volume II, *USAF Supervisory Examination (USAFSE) Guide*, contains all of *seven* sentences about contracting. (17:7-4, 7-5) Conversely, over 11 pages are devoted to budgeting systems and resource management. (17:Ch 10,11)

"Contracting out has not been included in the curricula of either the Senior NCO or Command NCO Academies."

Likewise, contracting out has not been included in the curricula of either the Senior NCO or Command NCO Academies. This is where the education process should begin for mid-level managers. The academic classroom, usually protected by non-attribution, is the ideal place to exchange contracting experiences and lessons learned about contracting out. The background and legal constraints of contracting out can be taught and explored in-depth. Both of these areas would serve to curb the perpetuity of opposition and increase the expertise of our NCOs in regard to contracting out. Still, education alone will not fully prepare mid-level managers for all their responsibilities.

Existing guidance for preparing the multitude of documents associated with the contracting process must be expanded. Checklists need to be developed to ensure all possible aspects and associated factors concerning a service job are taken into consideration during the job analysis and PWS preparation phases. Furthermore, examples and expanded guidelines must be made available for writing the surveillance plan. As it stands now, mid-level managers have to create these vitally important, lengthy, legal documents from scratch. The contracting process is not a learning phase; it is the real world of dollars and cents, with the Air Force's mission hanging in the balance.

Conclusion

The Air Force is becoming more and more involved in the contracting mode. As such, mid-level managers are expected to assume greater responsibilities. Mid-level managers must have all the preparation and guidance necessary to cope with the enormous responsibilities levied upon them. Ms Ayn Rand best synthesizes my position:

> To improve anything one must know what constitutes improvement - and to know that, one must know what is good and how to achieve it - and to know that, one must have a whole system of value judgements. How are these values to be selected except by gaining knowledge and tuning in on people. (6:33)

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The Ultimate Force Multiplier

"Victory comes to him who has the most forces, has the most technologically advanced arms, is best trained and best led, and fights with the greatest degree of bravery."

Again and again, history has proven this quote wrong, when forces with all of the above attributes have lost to forces which were inferior in all respects, but maneuvered better, adapted better to the tactical situation, or were otherwise able to neutralize effectively the advantages of the "superior" forces.

Very often, the element which has ultimately tipped the balance has been the victor's superior knowledge of the characteristics of the battlefield: where is the enemy, in what strength, and what are his intentions? These are variations of the first two laws of warfare as espoused by military strategists as far back as Sun Tzu through Napoleon Bonaparte and Karl von Clausewitz: know the battlefield, and know the enemy.

Commodore Thomas A. Brooks, USN

CAREER AND PERSONNEL INFORMATION

Civilian Career Management

How to Succeed in a Logistics Career

A civilian career in logistics is one of the most challenging and rewarding professions available in the Air Force today. It can provide a constant learning experience, with endless opportunities to demonstrate creativity, innovation, and accomplishment. Also, it provides self-satisfaction in knowing that one plays a direct role in sustaining the Air Force mission.

To achieve the executive professional levels in logistics management, participants must meet certain basic criteria and be knowledgeable of current statistics. Everyone should also be aware of the keys to success available through the Logistics Civilian Career Enhancement Program (LCCEP). These keys center around performance, education, multi-discipline and command experience, mobility, professionalism, and leadership. LCCEP addresses all these areas with specific career-broadening assignments and educational programs geared to place high-potential logisticians on a course to career success. The higher the aspirations, the more important the LCCEP keys become in reaching desired goals. For instance, out of all Air Force GM-15s in the logistics discipline, approximately 90% are LCCEP-managed positions; GM-14s, 70%; GM-13s, 60%; and GS-[illegible], 30%. The numbers speak for themselves—if individuals adopt the LCCEP keys to career success, they can prepare themselves to compete for top logistics executive positions in the Air Force.

LCCEP services a vast community with over 13,100 registrants currently on the rolls. The program also provides central referral for over 2,300 logistics positions worldwide, covering a wide array of specific disciplines. Astute LCCEP registrants can review data that show where these positions are located and effectively map career-broadening strategies. Furthermore, high-potential registrants who successfully compete and become LCCEP Cadre members receive enhanced visibility with key senior logisticians and priority consideration for managerial training opportunities that can place them on the fast track to executive development.

The LCCEP office is located at Randolph AFB, Texas, and is part of the Air Force Civilian Personnel Management Center. The PALACE Team staff members who administer the day-to-day operations of the LCCEP consist of Cadre career logisticians. They are dedicated and highly motivated, and are committed to professionalizing the logistics work force. Interested individuals can obtain specific information about any aspect of the LCCEP by calling AUTOVON 487-6464.

(Source: Steve Doneghy, AFCPMC/DPCML, AUTOVON 487-2498)

Military Career Management

Logistics Officer Manning Demographics

The Logistics Personnel folks at HQ AFMPC are often asked to provide an example of logistics force manning demographics. The following figures describe the current manning situation by grade and specialty:

Logistics Officer Manning by Grade

(Logistics officer manning figures include those officers currently assigned to an organization who are not in pipeline/training and who are Lt Cols through Lts in the following AFSCs: 004X - Director of Logistics; 009X - Deputy Commander for Resource Management; 31XX - Missile Maintenance; 40XX - Aircraft/Munitions Maintenance; 60XX - Transportation; 64XX - Supply; and 66XX - Logistics Plans and Programs)

GRADE	NR AUTH	NR ASGN	PERCENT
LT COL	1591	1390	87
MAJOR	2157	1363	63
FIELD GRADE	3748	2753	73
CAPT	3315	3057	92
LTs	593	1735	293
COMPANY GRADE	3908	4792	123
TOTAL	7656	7545	99

Manning by Logistics AFSC

	LT COL			MAJOR			CAPTAIN			LTs			TOTAL		
AFSC	1	2	%	1	2	%	1	2	%	1	2	%	1	2	%
004X	170	145	84	0	17	0	0	0	0	0	0	0	170	162	95
009X	100	86	86	0	2	0	0	0	0	0	0	0	100	88	88
31XX	87	65	75	129	91	71	224	241	108	5	44	880	445	441	99
40XX	697	597	86	921	566	61	1640	1424	87	359	975	273	3617	3562	99
60XX	149	145	97	230	155	67	458	415	91	126	222	176	963	937	97
64XX	209	163	78	395	258	65	544	533	98	103	314	305	1251	1268	101
66XX	179	189	106	482	274	57	449	444	99	0	180	0	1110	1087	98
TOTAL	1591	1390	87	2157	1363	63	3315	3057	92	593	1735	293	7656	7545	99

(Column 1 = Authorized Column 2 = Assigned)

Source: HQ AFMPC/DPMRSL

Consolidated Index, Volume IX-Volume X, Winter 1985 - Fall 1986

Part I
AUTHOR INDEX OF ARTICLES

Part II
TITLE INDEX OF ARTICLES

▶ FROM 14

"Air Force policy is that we will have five of every six aircraft flying at the end of 30 days."

Suppose every LRU on the aircraft had an MTBF of ten times the first 30 days' flying hours or, in our example, 650 hours. Then, in our perfect statistical world, we would expect only one aircraft in ten to experience a failure of a given LRU. In a 24-PAA squadron, 21 would be available even at the end of 30 days with no WRSK. Statistically, there is an 80% probability that we would have four or less failures and a 90% probability we would have five or less failures. Air Force policy is that we will have five of every six aircraft flying at the end of 30 days. With a maximum of four or five failures in a squadron of 24 aircraft, we achieve that goal by getting beyond the ten times the first 30 days' flying hours point on the reliability chart. In the 24-aircraft squadron, 19 or 20 aircraft would be operational after 30 days with no WRSK required.

Obviously, the further out on the chart we drive the items, the better off we are—maintenance decreases; WRSK is reduced or eliminated; transportation requirements are reduced; manning requirements are reduced; and, most importantly, combat capability is substantially enhanced, and we come closer to being able to operate from "bare base" conditions.

Progress Report on Draft Plans for Weapon Systems

Completed*		Initiated
A-10	E-3	A-7
B-52	F-4	B-1
C-5	F-15	HH-53
C-130	F-16	
C-141	F-111	
C-KC-135	T-38	

*Should be finalized by Apr 87

Conclusion

Weapon system management is becoming an Air Force process. Master plans are a giant step forward in this effort to maximize the capabilities of the weapon systems we have on the ramp. We expect these master plans to be computerized and on-line as living documents that allow SPMs to manage better, planners to forecast better, and programmers to allocate resources to best serve the USAF mission.

Best Article Written by a Junior Officer

The Executive Board of the Society of Logistics Engineers (SOLE) Chapter, Montgomery, Alabama, has selected "Taking Microcomputers to War: What Transporters Have Learned" (Fall 1986 issue), written by Captain Vaughn D. Wasem, USAF, as the best AFJL article written by a junior officer for FY86.

Technical Functions of Provisioning

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In a previous article, "Provisioning Management in the Air Force Today" (*AFJL*, Fall 1986), the authors addressed the structure and procedures of the initial provisioning process. Attention now shifts to the technical processes which establish the range and quantity of items needed to support a new system and which identify how those items are to be managed while in the Air Force inventory.

Processes

Establishing the source, maintenance and recoverability (SMR) code and provisioning factors for each supply item is the heart of the provisioning technical review. Properly defined SMR coding is the technical process of establishing methods of support, component relationships, repair determinations, and recoverability decisions for maintaining Air Force weapons, systems, and equipment.

Provisioning factors are management codes assigned during the provisioning process which accomplish three objectives:

(1) Establish the baseline for the requirements determination process.

(2) Project maintenance actions affecting supply.

(3) Provide a common language and format for logistics systems.

Examples of provisioning factors are maintenance factors, overhaul replacement percentages, condemnation percentages, and not reparable this station (NRTS) percentages.

The goal of provisioning is to ensure supply support for all systems entering the Air Force or Department of Defense inventory. The development and application of SMR codes and provisioning factors lead to the procurement or nonprocurement of spare parts and their subsequent deliveries to using activities.

In explaining this process, two special points are emphasized. First, logistics is a coequal partner with operations. Management codes are designed to support not only the operational concept, but also the logistical concept, of the end item. Second, the integrated logistics support (ILS) element of reliability and maintainability (R&M) plays a significant role in establishing and assigning SMR codes and provisioning factors. Reliability and maintainability are manifested in the maintenance concept developed for the item being provisioned.

The development of an SMR code evolves from critical decisions concerning service life prediction (how long an item will last until it breaks), repair or discard at failure (whether a broken item will be repaired), and the appropriate repair level (what level of maintenance is responsible for repair). These decisions have a great impact on the initial supply requirements and ultimately how much supply support will cost.

Repair level analysis is a management tool available to the provisioning manager to assist in developing and assigning SMR codes. Based on inputs of operational performance considerations and logistics resource requirements, this analytical tool provides the manager information based upon economic analyses. These analyses consider whether an item should be repaired or discarded at failure and, if it is to be repaired, at what maintenance level. In addition to this tool, provisioning managers use other factors which influence their decisions in assigning SMR and provisioning codes. Factors such as mission and priority of the end item, its planned deployment, environmental factors, and geographical constraints all play important roles.

SMR Codes

Department of Defense Directive 4140.40, *Provisioning of End Items of Materiel,* establishes the requirement to assign and use SMR codes.[1] These codes tell the maintenance community how to obtain repair parts and bits and pieces, how to maintain broken items, and who is authorized to condemn an irreparable item. This directive further directs a uniform SMR coding system be used jointly by all military services. A joint regulation (Air Force Regulation 66-45, *Joint Regulation Governing the Use and Application of Uniform Source Maintenance and Recoverability Codes)* has been published to establish the policy each service will use in the application of these codes. Technical Order (TO) 00-25-195 defines the SMR coding structure to Air Force users. This TO provides basic procedural instructions for initial SMR code application and the method by which using activities can request an SMR change.[2,3]

The SMR code is composed of a five-position alpha code broken into three specific areas. The first two positions of the SMR code are *source codes* indicating the manner of acquiring items for the maintenance, repair, or overhaul of end items. The third and fourth positions make up the *maintenance code* indicating the maintenance levels authorized to perform the required functions. The fifth position is the *recoverability code* indicating disposition actions on unserviceable support items. A sixth position is reserved for individual service use. The Air Force uses the sixth position to indicate the supply *expendability, recoverability, repairability code* (ERRC). Figure 1 is a breakdown of the SMR code with definitions of each position. This helps in understanding Figure 2, a matrix of the Joint Military Services Uniform SMR Codes used by the Air Force. (For deeper knowledge of SMR codes, refer to TO 00-25-195.)

The maintenance code is assigned in consonance with the established three levels of maintenance, as defined for Air Force operations:

a. Organizational maintenance (normally on-equipment, flight line-type maintenance).

b. Intermediate maintenance (normally shop level maintenance).

c. Depot maintenance (air logistics center maintenance or similar level contractor maintenance).

SMR CODE

SOURCE CODES	MAINTENANCE CODES		RECOVERABILITY CODES	
	USE	REPAIR		
1 2	3	4	5	6
MEANS OF ACQUIRING THE SUPPORT ITEM	LOWEST LEVEL OF MAINTENANCE AUTHORIZED TO REMOVE, REPLACE, AND USE THE ITEM THE MAINTENANCE LEVEL WILL REQUIRE ALL CAPABILITIES TO INSTALL AND ASSURE PROPER INSTALLATION (PRE-INSTALLATION INSPECTION, TESTING, POST-INSTALLATION CHECKOUT)	INDICATES WHETHER ITEM IS TO BE REPAIRED AND IDENTIFIES THE LOWEST LEVEL OF MAINTENANCE WITH THE CAPABILITY TO PERFORM COMPLETE REPAIR (ALL AUTHORIZED MAINTENANCE FUNCTIONS SUCH AS REMOVE, REPAIR, ASSEMBLE, MANUFACTURE, TEST)	INDICATES DESIRED DISPOSITION OF THE SUPPORT ITEM	RESERVED

Figure 1: Uniform Source, Maintenance, and Recoverability Code.

JOINT MILITARY SERVICES UNIFORM SMR CODING MATRIX

SOURCE				MAINTENANCE				RECOVERABILITY		ERRC CODE	
				USE		REPAIR					
1st Position		2nd Position		3rd Position		4th Position		5th Position		6th Position	
P	Procurable	A	Stocked	O	Remove/ Replace by Organizational level	Z	No Repair	Z	Nonreparable Condemn by 3rd Position Level	N	Nonrecoverable XB3 Condemn by Any Level
		B	Insurance								
		C	Deteriorative								
		E	Support Equipment, Stocked								
		F	Support Equipment, Nonstocked			B	No Repair Recondition	O	Reparable Condemn by Organizational (or Field or Depot)	P	Recoverable XF3 Condemn by Field
		G	Life of System Support							C	Recoverable XD1 (SCARS) Condemn by Depot
K	Component of a Repair Kit	F	Intermediate Kit	F	Remove/ Replace by Intermediate Level	O	Repair by Organizational				
		D	Depot Kit					F	Reparable Condemn by Intermediate (or Depot)	T	Recoverable XD2 Condemn by Depot
		B	In Both Kits								
M	Manufacture	O	Organization			F	Repair by Intermediate				
		F	Intermediate								
		D	Depot	D	Remove/ Replace by Depot Level	D	Limited Repair by O or F Level Overhaul by Depot	D	Reparable Condemn by Depot Only	S	Nonexpendable Support Equipment, Depot NO2
A	Assemble	O	Organizational								
		F	Intermediate								
		D	Depot							U	Nonexpendable Support Equipment, Organizational and Intermediate NF2
X	Nonprocured	A	Requisition NHA			L	Repair by Depot	A	Special Handling		
		B	Reclamation or Requisition by Part Number								
		C	Mfg Drawings								

Figure 2: Uniform SMR Codes Used by the USAF.

The responsibility for SMR code assignment rests with an equipment specialist at an air logistics center (ALC). This person will be assigned to the Engineering and Reliability Branch of the system program management or item management organization. Correct SMR codes and provisioning factors (or the approval of factors recommended by the supplying contractor) depend upon the availability of technical information and projected operational requirements, plus the ability of the equipment specialist to correlate this information with experience on similar operational equipment. This responsibility is further tempered by the contractor's logistics support analysis (LSA) and application of experienced judgment.

Once an SMR code has been assigned to an item, the code becomes a part of the TO illustrated parts breakdown (IPB). An SMR code must be assigned to each item identified by the IPB. Of course, operational or support concepts may change after an end item has been in the inventory for some time. Accordingly, the SMR code originally developed may require change. Requests for changes are submitted to the applicable equipment specialist via an AFTO Form 135, Source, Maintenance, and Recoverability Code Change Request. Procedures for requesting SMR code changes are contained in TO 00-25-195.

With the correct assignment of the SMR code, half of the provisioning function—the determination of which items to acquire—is complete. The second part of the process deals with quantifying the selected items.

Provisioning Factors

Provisioning factors provide the baseline for the initial requirements computation process. They also project maintenance actions that will affect the supply system. Various kinds of provisioning factors are used in computing materiel support requirements. These factors establish the relationship between how long a piece of equipment is in use and the number of times a failure or other replacement action can be expected to occur in one of its subassemblies or parts. Several provisioning factors developed (or approved from contractor recommendations) by the equipment specialist during the provisioning process are:

- Maintenance factor
- Overhaul replacement percent
- Base condemnation percent
- Depot condemnation percent
- Not reparable this station (NRTS) percent

A provisioning factor is a mathematical value expressing a relationship between a level of activity and the support required or available. For example, if an automobile can be driven 100 miles and uses 3.5 gallons of gasoline, the resulting factor relating miles driven to gasoline consumption would be 3.5 gallons of gas to 100 miles driven—or .035 gallon per mile. If individuals were planning a 1500-mile trip, they could then provision for gasoline by simply multiplying the two known factors: the planned program (1,500 miles) times the provisioning factor (.035) equals 52.5 gallons of gasoline for the trip.

Another term needing definition before discussing the various provisioning factors is operating program increment (OPI). Simply stated, an OPI is a standardized counting unit used to describe the forecast level of activity. The most familiar OPI used in the Air Force is expressed in flying hours. The standard OPI is 100 hours. Therefore, if the known flying hour program for a particular weapon system is 100,000 hours, the number of program increments is 1,000 (100,000 divided by 100). Another common program increment, used for munitions, is expressed as 1,000 rounds of ammunition fired. With this as background, the five basic factors can be examined:

Maintenance Factor - is the expression of the anticipated average maintenance replacement rate per operating program increment. The replacement must create a demand on the supply system for a like item. The common term for this demand is the mean time between demand (MTBD). For example, if the applicable program increment is 100 hours and the estimated MTBD is 1,500 hours, the maintenance factor would be .067. Thus, the maintenance factor would be expressed as .067 removals per 100 hours of operation (or .067/OPI).

Overhaul Replacement Percent - represents the percentage of time a replacement spare or repair part is used in the overhaul of the next higher recoverable assembly (NHRA). Supply parts used for the repair of items coded for depot level maintenance (SMR code L or D) require an overhaul replacement percent. If, for example, a rubber O-ring is needed to repair an air pressure regulator coded for depot repair, and the equipment specialist estimates the O-ring will be replaced 75 times during 100 overhauls, the resulting overhaul replacement percent would be expressed as 75% of the NHRA overhaul program.

Base Condemnation Percent - represents the portion of the failed items removed and processed for repair at the field level (organizational or intermediate level repair) which will be condemned. They may be condemned because they either are irreparable or exceed economical repair limitations. For example, if the equipment specialist estimates that out of 100 fuel pump failures, 10% of the items cannot be repaired, the resultant base condemnation percent would be 10% and would be expressed as 0.10 on the provisioning document.

Depot Condemnation Percent - represents the portion of failed items removed and processed for repair at the depot level which cannot be repaired and will be condemned during depot overhaul. Take the example of an air pressure pump coded for depot overhaul. If the equipment specialist estimates that 80 out of 100 pumps can be repaired, the condemnation rate for the pump would be 20% and be expressed as 0.20 on the provisioning documents.

Not Reparable This Station (NRTS) Percent - represents the portion of estimated reparable generations designated to be repaired in the intermediate repair shop but, for some reason, cannot be repaired there and must be forwarded to the depot. This NRTS percent only applies to those items with an SMR code of D (split repair - intermediate or depot) in the fourth position. As with previous percentages, the NRTS percent will be expressed on provisioning documents as a three-position number (for example, 0.25).

Conclusion

Of all logistical decisions made during the acquisition process, the development of SMR codes and provisioning factors must be rated as among the most important. These decisions determine which and how many spares and repair parts will be procured and available for use in the field. A weapon system or major piece of equipment is good only as long as it is able to perform its intended function. When it is unserviceable, its value is zero. Timely provisioning assures the right item is at the right place at the right time and right cost. Acquiring too many spares because of high factors causes excesses and higher inventory costs, as well as opportunity losses. Conversely, if not enough supply assets are procured because of faulty factoring, increased costs are incurred. Expedited deliveries and untimely acquisitions would be required to get the items to their needed locations to make up for initial shortages. The bottom line is that mission capability can be seriously impaired—a factor which could ultimately influence the outcome of a war.

Notes

[1]Department of Defense. DOD Directive 4140.40, *Provisioning of End Items of Materiel* (Washington: Government Printing Office, 1983), p. 2-1.

[2]Department of the Air Force. Technical Order 00-25-195, *Source, Maintenance, and Recoverability Coding of Air Force Weapons, Systems, and Equipments* (Washington: HQ USAF, 1984).

[3]Department of the Air Force. AF Logistics Command Regulation 66-68, *Functions and Responsibilities of the Equipment Specialist During Acquisition* (Wright-Patterson AFB OH: HQ AFLC, 1985).

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Current Research

Air Force Human Resources Laboratory FY86-87 Logistics R&D Program

The Air Force Human Resources Laboratory, Logistics and Human Factors Division, Wright-Patterson AFB OH, is the principal organization which plans and executes the USAF exploratory and advanced development programs in the areas of Combat Logistics, Acquisition Logistics, and Team Training Systems. Most of the Laboratory's efforts to improve Air Force logistics are managed within these sub-thrust areas. Some efforts are undertaken in response to technology needs identified by the Laboratory, but the majority of the work is in response to formally stated requirements from various commands and staff agencies within the Air Force. Many of our projects vary from basic research aimed at producing new fundamental knowledge to applied projects which are intended to demonstrate the technical feasibility and military effectiveness of a proposed concept or technique.

Following are some logistics R&D projects managed by the Logistics and Human Factors Division, which will be active during FY86 and FY87. (Contact: Colonel Donald C. Tetmeyer, AUTOVON 785-3713, (513) 255-6797)

DEMONSTRATION OF A UNIFIED DATA BASE (UDB) FOR LOGISTICS INFORMATION

OBJECTIVE: UDB is an on-line interactive and batch logistics support analysis (LSA) data base system to improve the documentation and accessibility of acquisition logistics support data. It will assist weapon system designers and logisticians throughout the weapon system design process. Focus of UDB is on the LSA record (LSAR). It conforms to MIL-STD-1388-2A, including Change 1.

APPROACH: UDB technology developed under an exploratory development program was demonstrated and tested on a major weapon system program in this advanced development effort. Interfaces with computer aided design, weapon system testing, and product performance feedback will be developed and evaluated. The Navy is a Beta test site. Validated software will be available early in FY88. (Capt Everton R. Wallace, LRA, AUTOVON 785-3871, (513) 255-3871)

MAINTENANCE AND LOGISTICS MODELS FOR COMPUTER AIDED DESIGN (MLCAD)

OBJECTIVE: To produce tested analytical models, data bases, and procedures for including maintenance and logistics factors within the computer aided design (CAD) process. A biomechanical model of the maintenance technician will be developed which will enable designers to evaluate maintainability during initial design.

APPROACH: Maintenance and logistics (M&L) factors relevant to CAD will be identified and associated with the various design phases of weapon system acquisition. Several representative factors will be selected for integration with CAD. Computer-based analytical models will be developed for selected factors. An existing biomechanical model will be selected and adapted to represent a maintenance technician. Data bases will be developed to support use of the models in a design environment. (Alan E. Herner, LRA, AUTOVON 785-3871, (513) 255-3871)

RELIABILITY AND MAINTAINABILITY IN COMPUTER AIDED DESIGN (RAMCAD)

OBJECTIVE: To develop methods and models to integrate reliability and maintainability (R&M) into weapon system design through the use of computer aided engineering (CAE).

APPROACH: A consortium of industry, universities, and the government will be established to accomplish three tasks: integrate R&M into a limited design process using CAE, conduct long-term R&D into two areas (developing R&M models and information management including applications of artificial intelligence (AI) to the design process), and develop an engineering curriculum which incorporates RAMCAD as an integral part. This is a joint effort with the Air Force Wright Aeronautical Laboratory (AFWAL), Rome Air Development Center (RADC), and the Army. (Alan E. Herner, LRA, AUTOVON 785-3871, (513) 255-3871)

MAINTENANCE PERSONNEL REQUIREMENTS FOR DISPERSED OPERATIONS

OBJECTIVE: To develop analytic techniques capable of evaluating the impacts of broadened job/task responsibilities for aircraft maintainers on combat performance in dispersed, small unit operations and on manpower, personnel classification, and training policies.

APPROACH: Alternative assignments of identified combat maintenance tasks will be evaluated through simulation. Criteria for reassigning tasks to overcome manpower shortages or to create resiliency in deployed units will be tested through innovative extensions of occupational/task analyses applied to existing maintenance specialties. The feasibility of specialty consolidation will be evaluated through a model that can balance costs of changes to job structures aimed at creating skilled generalists against risks of sortie loss in dispersed operations under the current specialist system. (Edward S. Boyle, LRC, AUTOVON 785-3795, (513) 255-3795)

MAINTENANCE LIMITATIONS IN A CHEMICAL ENVIRONMENT

OBJECTIVE: To develop and validate methodology to determine how the performance of critical, combat maintenance tasks is impacted by a chemical warfare environment. The methodology will be developed, then tested and applied in a simulated field, chemical environment. The data collected shall also be used to input combat models being developed by the Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL). All performance limitations observed will be isolated, identified, and reexamined. Suggested workarounds, policy and procedure changes, and equipment/clothing redesigns are expected to result from this work.

APPROACH: Initial research design and data collection methodology are being developed in-house. During Phase I, methodology was tested with data collection results sent to AAMRL for modeling inputs. Phase II will concentrate on and isolate specific performance limitations discovered during Phase I. These limitations will be further tested for a more exact isolation of the causes to determine the effects on combat sortie generation. Phase III will bring together the data collected in Phases I and II for an extensive analysis. Limiting factors, workarounds, and recommendations for present and future concern will be submitted through this Phase. (Capt Alan Diebel, LRC, AUTOVON 785-3771, (513) 255-3771)

AUTOMATED MAINTENANCE PERFORMANCE AIDS

OBJECTIVE: To develop and evaluate prototype automated aids for presentation of technical information for use by maintenance technicians through automation to allow selective data display tailored to individual skill and experience as well as to provide rapid and reliable update.

APPROACH: A series of small design studies were accomplished to establish system requirements for factors such as display resolution, data presentation formats, and the man/machine interface. Emphasis was placed on developing systems which are easy to use, provide all the information the technician needs, and increase the technician's capability to perform maintenance. The system was field tested at Grissom AFB IN. (Lt Jeffery D. Clay, LRC, AUTOVON 785-2606, (513) 255-2606)

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS)

OBJECTIVE: To develop an integrated information system for the flight line maintenance technician which will provide all the diagnostic, technical order, training, and work management data needed for job performance.

APPROACH: A series of design studies and prototype field tests will be conducted to establish the display formats, man-computer interface, and information requirements for IMIS. A portable maintenance computer will be developed in conjunction with the development of interfaces for airborne and ground-based computer systems. The prototype will be field tested to evaluate the design requirements for integrating and displaying maintenance information. (Capt Joseph Von Holle, LRC, AUTOVON 785-2606, (512) 255-2606)

AUTOMATED FLIGHT LINE MAINTENANCE AID

OBJECTIVE: To develop a prototype computer-based graphics and information system for use by maintenance technicians for on-aircraft maintenance—both routine tasks and battle damage assessment.

APPROACH: Hardware and software capable of storing, rapidly retrieving, and presenting both routine maintenance and automated battle damage repair data will be developed. The system will be a small, portable, rugged device capable of handling a variety of procedural, structural, and systems information. (1Lt Dean H. Orrell, II, LRC, AUTOVON 785-2606, (513) 255-2606)

COMBAT MAINTENANCE CAPABILITY

OBJECTIVE: To develop and test methods by which the Air Force can measure, quantify, and improve its combat maintenance capability. Such methods can be used by Air Force decision makers in determining policies, planning resources for combat, preparing units for combat, conducting operational exercises, enhancing combat logistics and maintenance effectiveness, and influencing the design of more supportable future weapon systems.

APPROACH: A four-phase, ten-task approach is being followed. These phases will critically examine the differences between peacetime and combat maintenance and the effects of these differences on the generation of effective combat sorties. The findings of the phase efforts will be summarized. Suggested changes in maintenance procedures, practices, and organization which appear to have the most significant impact on effective sorties generation capability will be submitted. Recommendations will be submitted for further study to determine feasibility and cost for incorporating the changes into operating policy. (Richard E. Weimer, LRC, AUTOVON 785-3795, (513) 255-3795)

LOGISTIC SUPPORT ANALYSIS OF MAJOR WEAPONS ACQUISITION

OBJECTIVE: To provide analysts and decision makers with the capability to use

automated procedures to assess the status of their combat readiness, capability, and sustainability in a personal computer environment. This capability currently does not exist at locations without extensive computer resources. This will directly affect the readiness of the Air Force. The Theater Simulation of Airbase Resources (TSAR) model was selected at the end of the first phase as the decision tool. Phase II is the actual downloading of TSAR to a personal computer.
APPROACH: The contractor's approach for Phase II of this Small Business Innovative Research (SBIR) is twofold. First, in Phase I, the formulation and validation of user requirements were accomplished. Second, in Phase II, PC-TSAR will be iteratively developed from the mainframe version of TSAR. Modules of TSAR code will be downloaded and tailored to the specific personal computer. The contractor will test the modules individually as they are downloaded and then integrate and test the model as a single unit of code. However, the possibility exists that the model may not produce the same results as the mainframe version. Some of the capabilities of the TSAR model may require tailoring to fit the memory size constraints of the personal computer. (Lt Scott R. Matthes, LRL, AUTOVON 785-8418, (513) 255-8418)

GRAPHICS POST PROCESSOR FOR LOGISTICS MODELS
OBJECTIVE: To simplify the output of the TSAR and Dyna-METRIC logistics models. This will increase the usefulness of these models as analysis tools. Graphic output will enable a decision maker to more quickly and simply understand the results of these logistics models. This effort will allow this post-processor to be implemented on both a mainframe, as well as a personal computer. Phase I will yield the necessary information to determine the feasibility of developing the desired post processor. User requirements will be determined and preliminary specifications developed. Phase II, if accomplished, would provide a means to significantly extend the management utility of the models and aid model analysis and interpretation.
APPROACH: The contractor has developed a general approach for Phase I of this Small Business Innovative Research (SBIR) to determine the feasibility of creating a graphics post processor for TSAR and Dyna-METRIC. This includes identifying user requirements and developing preliminary computer program specifications. This will fulfill the Phase I objectives. (Lt Scott R. Matthes, LRL, AUTOVON 785-8418, (513) 255-8418)

TSAR/TSARINA PREPROCESSOR:
OBJECTIVE: To simplify the means by which data bases are entered into the TSAR and the TSARINA logistics models. The maintenance of these data bases will also be expedited by the results of this project. This effort is to be completed so these processes can be accomplished on a mainframe as well as a personal computer. Phase I will yield the necessary information to determine the possibility of developing the desired preprocessor. User requirements will be determined and a prototype system developed. Phase II, if accomplished, would provide a means to create data bases in a human factors engineered environment. It would also facilitate editing, and thus maintaining, relational data bases for sensitivity analysis.
APPROACH: The contractor has developed a general approach for Phase I of this Small Business Innovative Research (SBIR) to determine the feasibility of creating a preprocessor TSAR and TSARINA. This includes identification of user requirements and the development of graphic displays which are to be linked to data definitions, relational data bases, data base rules, and a runstream generator. Test data will be loaded and a prototype system demonstrated. (Lt Scott R. Matthes, LRL, AUTOVON 785-8418, (513) 255-8418)

LOGISTICS ANALYSES FOR THE INTEGRATED COMMUNICATIONS, NAVIGATION, IDENTIFICATION AVIONICS (ICNIA) SYSTEMS
OBJECTIVE: To identify tools and techniques which incorporate logistics engineering parameters into system design during the conceptual phase. These analysis techniques will be demonstrated by applying them to the front-end analysis portion of systems in conceptual design such as ICNIA or the Self- Repairing Flight Control System. Among the unique problems being addressed is the development of analytic reliability and fault-tolerant analysis techniques.
APPROACH: This effort will apply several major tasks to two conceptual ICNIA architectures and the Self-Repairing Flight Control System. The major tasks involve developing front-end analysis techniques in the areas of reliability, maintainability, fault tolerance, and survivability, and applying them to conceptual designs. (Lt Lee Dayton, LRL, AUTOVON 785-8418, (513) 255-8418)

WARTIME LOGISTICS DEMAND RATE FORECASTING
OBJECTIVE: To provide a means for predicting, measuring, and testing wartime demands on logistics resources worldwide. Combat data will be collected and used to describe the difference between peacetime and wartime demand rates. These data will be placed in a computerized data base and analyzed in order to develop the necessary tools to perform the forecasting of wartime demand rates.
APPROACH: This effort will apply the same tasks to similar parallel efforts. The study has been divided into five tasks: collect combat data, analyze the combat data, insert data in a retrieval system, develop automated analysis packages, and document results. The end products of this study are software, user's guide, programmer's guide, and applicable combat data bases. (James C. McManus, LRL, AUTOVON 785-8418, (513) 255-8418)

UNIFIED LIFE CYCLE ENGINEERING (ULCE)
OBJECTIVE: To develop, demonstrate, and transfer to application, by 1995, the technologies needed to provide integration of "design for producibility" and "design for supportability" with design for performance, cost, and schedule.
APPROACH: Develop computer aided design (CAD), computer aided manufacturing (CAM), and computer aided logistic support (CALS) design and analysis software. Integrate CAD, CAM, and CALS software in a design environment and form a university-industry consortium to speed transition of both individual and integrated products. (Capt Thomas J. King, LRL, AUTOVON 785-8418, (513) 255-8418)

WARTIME DEMAND RATES FOR AIRCRAFT ELECTRONIC COUNTERMEASURES (ECM) EQUIPMENT
OBJECTIVE: To develop and improve methodology for defining, quantifying, and generating demand rates for aircraft ECM equipment. The products should provide better logistics indicators for improved forecasting of war readiness spares kit (WRSK) requirements in relationship to available dollars and subsequent forecasting of spares requirements computation and capability assessments. The developed methodology will provide information and impact on improved wartime logistics indicators, resource requirements (manpower, WRSK, spares, and support equipment), and aircraft availability in wartime environments.
APPROACH: An ECM "Pilot Study" was accomplished in FY83. The main thrust of the pilot study was geared to four areas: assessing the utility of a two-year study, bounding the problem within workable limits (data base), stating the objectives of the major study, and deciding upon the end product of the ECM study. The ECM study will be divided into five functional areas: gathering data (combining historical and operational data), identifying solutions and method for selection to include first order test for utility, formalizing selection method, testing selection method and evaluating the methodology, and documenting results of study and translating data into requirements computation and capability assessments. The end product of the study will consist of methods used to compute wartime ECM demand rates and a report that translates data into requirements computation and capability assessments. (Capt William M. Weaver, LRL, AUTOVON 785-8418, (513) 255-8418)

INTEGRATED LOGISTICS/OPERATIONS ASSESSMENT MODEL
OBJECTIVE: To develop a computer capability to accurately assess theater-wide combat logistics systems resources and requirements.
APPROACH: Initially, this effort will assess the needs to users, requirements for model integration, inventory of existing models and integration techniques, hardware constraints, etc., to determine the scope of the integration effort. Once this feasibility study has been performed, a follow-on effort will be undertaken, if warranted. The integration of specific logistic, operations, transportation, etc., models will result in a theater-level, comprehensive "super" model which will have the capability to conduct extensive, systems level, two-sided conflict where each of the opposing forces would be characterized by their respective concepts of operations, deployment, maintenance, logistics, etc. Given the modularity of current models, advances in computer technology, and availability of computerized data bases, this type of integration is now a potential. (Capt Maureen Harrington, LRL, AUTOVON 785-8418, (513) 255-8418)

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(Continued from Fall issue)

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1Lt Timothy E. Eden ADA-161710 LD65144A
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Captain Jennifer A. Furru ADA-161709 LD65143A
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Captain Robert A. Bathelor ADA-162242 LD65127A
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1Lt Michael W. Helton ADA-161205 LD65112A
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Captain Kenneth A. Kennedy ADA-161744 LD65150A
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LOGISTICS WARRIORS

PROJECT TURNKEY: BOLDNESS PAYS OFF

Since 1962, all military construction in Vietnam had been entirely in the hands of the Navy through cost-plus-fixed-fee (CPFF) contract with a joint venture of US companies known as RMK-BRJ. However, if a critical priority existed and contractor capabilities were committed to even higher priorities, the MACV Director of Construction could allow the Air Force to find its own contractor. The Air Force needed another base for tactical fighters before the end of 1966, but the Navy officer in charge of construction (OICC) said that the soonest he could provide the base, using RMK-BRJ, was June 1967. This was unacceptable.

"Navy OICC personnel jokingly proposed that the Air Force obtain their own contractor for Tuy Hoa."

It was jokingly proposed by Navy OICC personnel that the Air Force obtain their own contractor for Tuy Hoa. However, the USAF took the proposal seriously and formulated the concept to use a CPFF, design-construct contract monitored by a decentralized construction agency, apart from RMK-BRJ, which was known as Project Turnkey. There was considerable skepticism from the MACV Director of Construction, the Army Corps of Engineers, and the OICC about the Air Force's ability to accomplish Project Turnkey. However, General Westmoreland (MACV Commander) stated we needed a base and pushed to allow the Air Force to try it.

The JCS approved Project Turnkey and it was spearheaded by the Directorate of Civil Engineering, HQ USAF, and by Brigadier General Guy H. Goddard, Deputy for Construction. The organizational plan was a joint effort of the Deputy Chief of Staff for Civil Engineering, HQ PACAF (Colonel Henry "Fritz" Stehling), the 7AF Civil Engineer (Colonel Archie Mayes), and the Directorate of Civil Engineering, HQ USAF. On May 31, 1966, a contract was signed with Walter Kidde Constructors, Inc., of New York.

RMK-BRJ argued that their construction program, then worth $500 million, was already straining the market for construction materials and equipment, the capacity of Vietnam's ports, the ability of Pacific shipping, the Vietnamese labor market, and the Vietnam economy. AFCE set up certain ground rules to isolate project Turnkey from RMK-BRJ construction. These ground rules were:

(1) All men, equipment, and materials had to come in over the beach at Tuy Hoa.

(2) Multi-skilled US labor would build the base with local labor coming only from the Tuy Hoa area.

(3) Workers were paid only 5% of their wages in Vietnam with the remaining 95% being deposited in accounts in the US.

(4) Project Turnkey equipment and materials had to be shipped from East Coast and Gulf ports.

(5) US employees had to stay out of local politics and their conduct and impact on the local nationals and the economy had to be minimized.

Project Turnkey was the first design-construct contract the government had awarded since World War II and was the first time during the Vietnam conflict that anyone but the Navy's OICC had handed out a construction contract in SEA. The project was to include two runways for jet operations, a 4000-man cantonment area, operational facilities, petroleum, oil and lubricants (POL), and the necessary supporting industrial plant. In addition, certain incentives for Kidde were written into the contract for early completion.

"Tuy Hoa's construction was the fastest, most economical, and best controlled construction in Vietnam."

The first runway was completed six weeks ahead of schedule. It was an AM-2 runway 9000 by 150 feet. Kidde's subcontractor for horizontal construction (B. B. McCormick & Sons, Inc., of Jacksonville, Florida) built this runway under time and under cost in spite of the extremely heavy and early monsoon rains. The second runway was a parallel, 9500-foot, concrete runway. Vertical construction work at Tuy Hoa was simply designed and construction consisted primarily of the erection of prefabricated, modular facilities.

Project Turnkey was completed in just 210 days. It allowed four F-100 squadrons to be bedded down in December of 1966 and the entire project was completed under time and under cost. Project Turnkey also demonstrated the value of using off-the-shelf materials and equipment. Since AFCE was its own procurement authority for this project, they were able to purchase readily available commercial products for use at Tuy Hoa. Kidde was able to use familiar, proven materials and equipment, with minimum procurement lead time. Tuy Hoa's construction was the fastest, most economical, and the best controlled construction project in Vietnam.

Captain Dean Waggoner and Lieutenant M. Allen Moe, *A History of Air Force Civil Engineering Wartime and Contingency Problems From 1941 to the Present* (AFIT/GEM/LS/855-23).

WAR GAMES IN OMAN

ALMAHATTAH, Oman—After five days of demanding military effort for 5,000 British troops and their Omani friends, it was time to look at the lessons learned.

The first logistics lesson from Operation Swift Sword, a British colonel emphasized, is the importance of a constant supply of water in a desert environment.

Soldiers need water, and their machines need water. A high percentage of the supplies sent to the commandos and the airborne troopers, who formed the majority of the British force, was water brought up in the familiar jerrycans of World War II.

One night, however, the commandos conceded that they had more water than they could handle. A sudden cloudburst washed away tents, blankets, and spare clothing. Eventually the rain ended and the losses were recovered, but as a young major said, "You never heard such language."

A second lesson—and British and Omani officers agreed that all the lessons were applicable to all forces involved directly or indirectly in the Middle East—reinforced the all-arms concept that the United States Army and Air Force advocate.

The objectives for the allied force, which was combating hypothetical invaders, would have been out of reach for ground forces alone. But the combination of sustained artillery fire, repeated aerial attack and tanks as well as infantry provided a convincing answer to doubters.

The strategic lesson that the Omanis and the British hope will be observed by Oman's neighbors is that sufficient air transport now provides a distant power with the capacity to intervene quickly and effectively to help a friend or avert a crisis.

Drew Middleton, *New York Times,* 14 Dec 86.

R&D IN SEA

In the application of airpower, a few areas should be looked at closely and we should benefit from the experience.

First is the fact that operational units at wing level and below are only as effective as morale and esprit de corps allow. Combining dissimilar units under one wing causes friction within the wing - if the operations of each are not understood by the other. Such is the case of the F-4, AC-130, and C-123 Blackspot in the same tactical fighter wing. All have important roles in the war, but they have dissimilar problems and requirements.

Secondly, application of new systems and equipment is difficult in the face of human nature and an inflexible command and control system. Centralized control and an excessive amount of restrictive rules of engagements have forced the Air Force into the position of running a war by procedures rather than by command. Requirements are written that are satisfied after the expenditure of many months and tremendous amounts of money only to find that they won't fit into the command and control system. Decentralizing the command and delegating the responsibility and authority to a somewhat lower echelon will allow for more flexibility in utilization of resources available.

Thirdly, requirements are written by the operating command, which is as it should be, but they are written too many times based on simple desires. Little responsibility is placed on the writer to insure he is reasonable and that he (or his successor) will actually implement the new equipment into the operation when it arrives. Three things can help correct this. The requirements generator should have working with him a technical R&D man that can assist him in writing a realistic, yet challenging, document. This man should have direct communication with the R&D community and be backed up by his organization in the CONUS. Secondly, the requirement, once approved, should become the forcing function on the using command to make it mandatory that plans be made to accommodate the resulting equipment. This includes altering the command and control system if necessary. Thirdly, the using command (including TAC) should not be allowed to evaluate the new equipment in view of deciding whether they want it or not. Their evaluation should be limited to how well it works and to learning about it. Systems Command should be responsible to fulfill a requirement and have the authority (and be responsible) to simply state that the equipment is being delivered. The using commands' inputs should be limited to the required available date and requirements phase.

"Millions would have been saved if we were at least ready for the SEA conflict on paper."

Another lesson that should have been learned is that we cannot wait for a shooting war to start getting ready. This appears to be the American way. Since the R&D liaison approach has paid off so well in helping get us up to speed in SEA, and we did the same thing in the Korean War to get things moving, it appears a "peace-time" arrangement would even be of more benefit. Peace-time field interfacing between the R&D and the operating people would give us a more "readiness" posture. The operators would be up-to-date on existing technology; they'd know what is being developed for other theaters; and they would have their requirements already documented and validated. In turn, the Systems Command (and Logistics Command) would know what is needed, and even if it weren't funded for production, research and exploratory development could be in progress. Also, the R&D in progress would be directed to worldwide requirements and there would be time for trade-offs and re-definition of requirements to save dollars. Millions would have been saved if we were at least ready for the SEA conflict on paper. We should insure that each threat area in the world (almost everywhere) has an R&D representative working with the requirement generator. The magnitude of such a liaison function should be small and flexible to suit the need. But at least one such scientist/engineer should be in each numbered Air Force. He should work out of a common focal organization in the CONUS, so that the communications get channeled into the correct area. Support to him can be given, when called for, for short periods by needed experts.

The Air Force has no apologies to make for its fighting force in SEA. Every man has proven himself equal to the job. We have lost a lot by two extremes. One is over-control and therefore stereotyping the war. Little has been left to the ingenuity of the wing commanders. The other extreme has been the resistance of the commanders (wing level and higher) to accept new systems and equipment. It must be remembered that all gunships (AC-47, AC-130, etc.) and the Blackspot C-123 systems were forced upon the using commands. They now have great appreciation for them. Yet, today, newer systems have been rejected without a try because of resistance to change (i.e., Pave Arrow, Compass Sight, Tropic Moon III, BIAS/Hunter).

There have been several innovations by the operational units that have been well worthwhile. Because of them, our operational effectiveness has increased. Examples are: Black Crow on Blindbats, Loran D bombing, Laser/NOD on Blindbat, Continuous Computing Gunsight on F-105.

From all the Air Force personnel who have served in SEA, we should be able to establish a lasting Limited War posture. Paraphrasing former Secretary of the Air Force, Dr Brown, "The Vietnam conflict has shown us that the Korean War was not a fluke but a manifestation of Communist aggression since we have deterred them from general war." This statement only points out that we are fighting communism the way they stated they wanted it. Documents were written in 1922 advocating limited wars of "liberation." We had better learn from these last two wars and be prepared to fight future wars just like them - somewhere else. The alternative is to give up the job.

Colonel W. F. Fagan, Commander, Systems Command (SEA) Liaison Office, Tan Son Nhut AB, RVN, Corona Harvest End-of-Tour Report, July 1969.

Let's Get Rid of Management

People
don't want
to be
managed.
They want
to be led.
Whoever heard
of a world
manager?
World leader,
yes.
Educational leader.
Political leader.
Religious leader.
Scout leader.
Community leader.
Labor leader.
Business leader.
They lead.
They don't manage.
The carrot
always wins
over the stick.
Ask your horse.
You can *lead* your
horse to water,
but you can't
manage him
to drink.
If you want to
manage somebody,
manage yourself.
Do that well
and you'll
be ready to
stop managing.
And start
leading.

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Air Force Logistics Management Center
Gunter AFS, Alabama 36114-6693